(COPY FOR MR. J. ALLAN ROSS)

[Engineering data

HYDRO-ELECTRIC POWER COMMISSION
OF ONTARIO

COPY OF
COMMENTS ON EVIDENCE GIVEN BEFORE THE COMMISSION BY CONTRACTORS ON MAY 18TH, 22ND AND 23RD, 1923,
AND OF
ANSWERS TO QUESTIONS ITEMIZED IN MR. BOWER'S LETTER TO MR. POPE OF JUNE 14TH, 1923.

TRANSCRIBED AUGUST 7TH, 1923

Copy of

COMMENTS ON EVIDENCE GIVEN BEFORE THE COMMISSION

BY CONTRACTORS ON MAY 18th, 22nd and 23rd, 1923,

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ANSWERS TO QUESTIONS ITEMIZED IN

MR. BOWER'S LETTER TO MR. POPE OF JUNE 14th, 1923.

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

Prefatory Note

This document is an exact transcription of the text of an undated document prepared by Mr. H. G. Acres under the title "Comments on Evidence given before the Commission by Contractors on May 18th, 22nd and 23rd, 1923". The original illustrations have been re-drawn and copied with the aid of the camera. The transcription consists of fifty-nine pages of text, together with seventeen appendices.

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In addition, this document contains an exact transcription of a memorandum entitled "Answers to Questions itemized in Mr. Bower's Letter to Mr. Pope of June 14th, 1923", being the questions and answers in full in numerical order. The paging herein is marked Q-1 to Q-8.

These transcriptions have been made following Mr. Bower's letter of instructions to me under date of August 2nd, 1923, from the duplicate copies furnished to me by Mr. Pope.

Walter J. Francis

Consulting Engineer.

Toronto, August 7th, 1923.

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Walter J. Francis

Consulting Engineer.

Toronto, August 7th, 1925.

HYDRO-ELECTRIC INQUIRY COMMISSION

COMMENTS ON EVIDENCE GIVEN BEFORE THE COMMISSION
BY CONTRACTORS ON MAY 18th, 22nd and 23rd, 1923.

PAGE 5278:

CHAIRMAN - If you had been in the place of the Commission and had to have the work done, how would you have gone about the organization of your forces to do it?

MR. LARKIN - I would have split the organization up under proper headings; the engineering first, then construction, then operating. I would have had probably three or four divisions, and then I would have endeavored to secure, as a result of investigation, the best men from the standpoint of their reputation and performance that I could get to head these departments. That is what a contractor would do in a big undertaking.

This is precisely the procedure followed by the Commission, as evidenced by the organization charts in FR, chapter F, and also as outlined in Appendix 4 of my report of January 10th, 1918.

Practically without exception, all of the important positions in this organization were filled by men who were specialists, either by virtue of engineering or actual construction experience, in the development of Niagara power. Furthermore, Works Engineer Goodwin and General Superintendent Angell had spent the greater part of their business lives on power construction work of a heavier and more extensive character than any Canadian contractors who were in business in 1916 and 1917, or since. These men, therefore, had a following of experienced subordinates fully as extensive and competent as the organizations of the Foundation Company and Fraser-Brace Company. For instance,

the superintendent on Division No. 1, the superintendent on Division No. 4, the master mechanic, the general repair foreman, the general track foreman, had all worked for Superintendent Angell, and with each other, for years previous to coming on this work. One important exception to this rule was Superintendent Scriven who had charge of Divisions Nos. 2 and 3, and he was specially recommended to Mr. Angell by myself. Mr. Scriven, being a practical contractor of many years' experience, also brought with him on to the work a considerable number of men who had worked for years with him and with each other.

Under the circumstances, not much weight can be assigned to the argument that the construction force was an organization patched up in a loose, haphazard manner.

Precisely the same argument applies to the engineering organization, and cannot be summarized better than by a letter written to Premier Drury by Brigadier-General Mitchell, copy of which is attached hereto - Appendix 1.

Page 5283:

> MR. HANEY: Here is the top layer of earth (referring to FR, chapter H, page 131). There is 9,000,000 cubic yards. Would it be advisable to do the work as shown on this profile or keep right on the surface and use a number of shovels and get the earth off so that the rock would be reached as quickly as possible; or do you think it would be more practicable to do the work as outlined by the black lines; that is, working in short sections? We want some man to tell us the method a practical man would have followed.
>
> MR. LARKIN - Of course, the best would be to get this earth off the top.

There is an implied criticism in Mr. Haney's question, having to do with

the appearance on the profile mentioned, that the excavation work was started here and there along the canal in a more or less haphazard manner, and without the appearance of a definite working program.

Bowman's Gully was over 80 feet deep where it crossed the line of the canal and extended eastward to the Niagara River and westward for a distance of about 2,000 feet from the centre line of the canal. This gully, together with the two main line tracks of the Grand Trunk, and the single track of the Michigan Central, formed an impassable barrier to through communication at the start of the work. Being as deep as it was, Bowman's Gully was also naturally the low drainage point for both earth and rock for more than half of the total length of the canal. Had it been possible to follow the originally contemplated scheme of procedure, Bowman's Gully would have formed the general sump for all the canal drainage, and when the work was started in 1917 it was the intention to work the excavation plant simultaneously north and south from this point. This intention is quite plainly indicated on the profiles mentioned in Mr. Haney's question above. On these profiles the deeper cuts indicate the work done by the large electric shovels, and the lighter cuts indicate the work done by the rail-road type shovels. These latter shovels were engaged either in stripping light overburden or in taking out pilot cuts for the grade of the loading tracks which served the big shovels. One small patch of excavation near mileage 5 on these profiles is the excavation for the abutments of the N. S. & T. railroad bridge, and has no direct relation to the general scheme of earth and rock excavation.

Mr. Larkin's answer to this question is, of course, the only one, but taken in conjunction with the questions and answers on the following page, it is

the appearance of the profile mentioned, that the excavation work was started here and there along the canal in a more or less haphazard manner, and without the appearance of a definite working program.

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Mr. Lawyer's answer to this question is, of course, the only one, but taken in conjunction with the questions and answers on the following pages, it is

apparently the idea that the overburden should have been removed complete, either with the big shovels, or preferably with small 70-ton shovels, before touching the rock. Insofar as the operation of the big shovels is concerned, this was impossible because large quantities of crushed rock were needed from the very beginning of operations for road metal and track ballast. Furthermore, in 1918, when No. 2 shovel started working south from the main line of the Grand Trunk, large quantities of excavated rock were absolutely necessary for holding up the soft banks which obtained continuously almost up to Lundy's Lane. Also, in the fall of 1918, when operations commenced on the St. Davids disposal area, more rock was needed to anchor the trestles than could actually be spared, on account of more urgent requirements elsewhere. It was, therefore, absolutely necessary to carry on earth and rock excavation work simultaneously.

In the matter of using 70-ton shovels, the experience on this work throughout has been that with the exception of about half a mile each side of the summit at Lundy's Lane, there was no earth bottom anywhere on the canal which would hold up the railroad type shovel at a depth of more than 20 feet below the natural contour. As a matter of fact, at many points between the Grand Trunk and Winery Road, it was found impossible even to take the railroad cut out to the designed grade. The result was that where possible, the grade was elevated, and where this was not possible the excavation was taken out with a small dragline.

Through this latter section the maximum cut a railroad shovel could safely handle was about 9 feet below the natural surface.

North of Bowman's Gully the use of railroad type shovels in the heavier

portion of the overburden would have been impracticable, not only on account of soft bottom, but from the standpoint of car service, as the natural slope of the rock surface at this point was such as to make it impossible to pull out loaded trains.

Failing the big shovels as actually used, the only possible method of removing this overburden would have been to use draglines of a size and reach greater than any so far constructed. These machines might have given reasonable service if the material could have been cast, but they would have been an impossible proposition for loading dump cars. The largest dragline now built would not work efficiently in cuts exceeding 50 feet in depth, on account of the steep angle of drag, even at maximum length of boom.

PAGE 5285:

MR. HANEY - On that basis, assuming that at 2,000 yards per day, 25 days, 50,000 yards, and with 10 shovels, 500,000 yards a month, and in 10 months, 5,000,000 yards, leaving 2 months for winter weather; six months in summer on double shift, and get out 6,500,000 yards in the year. I am speaking of the stripping.

MR. LARKIN - Of course, I think that is a fairly rosy estimate.

In connection with the above quoted observations, please note Appendix 2 attached, which covers actual authentic records of the performances of the railroad type shovels under the working conditions assumed by Mr. Haney; namely, 100% efficient train service, competent and efficient shovel operation, first-class mechanical condition of shovels, and overburden of the type encountered in the four miles of route between Station 370, north of the Grand Trunk Railway, and Lundy's Lane. These records cover the operation of railroad type shovels in the top cut only.

In the case of shovel No. 3, the 10 foot depth was abandoned when it came to a point where about five 20-yard cars of crushed stone had to be placed under the trucks and jack-arms to dig about two 20-yard cars of muck.

These records, and the working conditions of which they furnish evidence, would appear to indicate that Mr. Larkin is correct when he states that a continuous average output of 2,000 yards per day in this material with a railroad type shovel is "a fairly rosy estimate".

PAGE 5286:

MR. HANEY - The disposal grounds for the Chippawa work were practically all on trestles?

MR. LARKIN - So I believe; I never saw it.

As a matter of fact, out of the total of 9,909,366 yards of earth and rock deposited in the St. Davids and Lundy's Lane disposal areas, only 3,697,180 yards, or 37% of the total, was dumped from trestle. The balance of 6,212,186 yards, or 63% of the total, was dumped from track which was moved out as occasion required, after the dumps had been plowed wing-wide.

The trestles were not used for dumping purposes as long as there were sufficient wing-wide dumps in proper shape to handle trains. The primary function of the trestle dumps was to ensure, as far as possible, uninterrupted dumping facilities while track raising or track shifting was in progress on the wing-wide dumps.

At Lundy's Lane, it was, of course, necessary to construct a certain amount of trestle to provide the necessary dumping height, as there were no side hill

contours similar to those at St. Davids.

The point is that if <u>all</u> the material had been dumped from trestles, it might have been possible, with a great deal of trouble and expense, to use flat cars and Lidgerwood unloaders, for earth <u>only, where the material was of such a nature that it would stay in the cars</u>. This procedure would have been possible by reason of the fact that the dump trestles could have been built on tangents. Under the conditions that actually existed, however, only 39% of the material, representing the <u>dry</u> portion of the canal earth, could have been handled in this way, because the tracks on the wing-wide dumps were never tangents, and did not need to be, as the tracks were swung to follow the most favorable contours and to avoid soft spots in the banks. Under such conditions the alignment of these wing-wide dump tracks was being <u>constantly shifted</u>, and the use of unloading plows would have been utterly impossible.

If anyone were disposed to argue that it would have been in the interest of economy to dump <u>all</u> the material from trestle, it would not be necessary to reply to this contention on the basis of economics, but simply to state that there was neither material or labor available for building them, and even if labor and material <u>had</u> been available, the congestion on the dump areas, resulting from the enormous volume of timber work that would be necessary, would have destroyed the primary function of the disposal areas, which was to absorb the output of the shovels as fast as it could be delivered. Furthermore, the trestles would all have to be parallel to each other, in order to make as full use of the disposal area as possible.

<u>Appendix 8</u> attached gives certain information in connection with the trestle

construction. These trestles were built as and when required, and during the greater portion of their period of construction their building was governed to a large extent by the availability, or otherwise, of labor and material. Another factor concerning the construction of trestles was the fact that it was necessary to have a certain amount of rock available to dump around the footings where the bents ranged higher than about 30 to 35 feet. If this were not done the sliding of the soft material would have swept the higher bents out and destroyed them. The average height of the trestles at St. Davids was 47 feet.

PAGE 5287:

MR. HANEY - Of course, the car they use the plow on now, is practically a closed car, the Roger type?

MR. LARKIN - Yes.

MR. HANEY - So that any soupy material might be held there as well as in a dump car?

MR. LARKIN - Yes.

This statement is not correct, the type of car referred to being not in any sense of the word a closed car, as both ends of the car must be free to allow the passage of the plow. The soupy material referred to would have flowed like water out of both ends of these cars and would have made such a mess of the tracks that it would have been impossible to move the train from under the shovel. While the shovels were working in this material it was necessary to keep a gang of about 30 men doing nothing else but clear away the accumulation of slop and droppings. Furthermore, it was necessary to run a flanger over the track system about once a week in order to keep the tracks safe for traffic. On

the disposal line this accumulated slop finally filled up the drainage ditch on the west-bound track, and it was necessary to put in a dragline to clear it out. All this happened with dump cars having absolutely tight ends, and side doors fitting as tight as it was possible to make them.

If open-ended cars had been used, it can be stated without any exaggeration whatever that not a yard of this soupy material would ever have reached the St. Davids disposal area.

In Appendix 4 attached will be found some further discussion having to do with the handling of this material with long trains and dumping with a Lidgerwood unloader.

PAGE 5287:

MR. GREGORY - Was there much soupy material?

MR. FRANCIS - The worst I ever saw. They could not build the sides without rip-rapping with rock.

MR. HANEY - That was due more particularly to the fact that they used large shovels. If they used smaller shovels they could have stepped down and would not have had to lift 60 feet.

The soupy material extended for four miles along the route of the canal from Station 370, north of the Grand Trunk bridge, southward to Station 170, just north of Lundy's Lane. The yardage involved was 5,885,388, or about 61% of the total yardage of overburden removed from the canal. In addition to this "soup" there was treacherous "gumbo" on the south side of Lundy's Lane, where piling was needed to hold the loading tracks for about 2,000 feet.

The necessity for rip-rapping the sides had nothing whatever to do with the size or type of shovel used, as the material was of such a nature, and the

ground water conditions were such that the banks were not only unstable, b ut constantly sliding, if left unsupported. The bank would have held up for the first bench, which condition was proved by the fact that the banks of the pilot cuts and of the railroad cuts usually held up satisfactorily. In some places the second bench would probably have held, but in most places it would have slid out and buried the shovel. The completion throughout of the second bench would have seen the final finish of the railroad type of shovel, for two reasons; first, because, lacking all other untoward conditions, the shovels would have dropped out of sight in the soft bottom; and second, because, under such conditions, these shovels would have at least 20 foot banks above them which would not hold under any conditions, unless heavily surcharged with rip-rap, and under the conditions assumed it would manifestly be impossible to rip-rap these 20 foot slopes. The only condition that made rip-rap possible was the fact that the big shovels worked from rock and took all the overburden out to a finished slope in one bench, thus making it possible to dump rip-rap in its final permanent position. If these big shovels had not been used so as to permit the placing of rip-rap as above described, the removal of the overburden between the Grand Trunk bridge and Lundy's Lane would have been impossible, and the scheme as a whole would have been a complete failure as a result.

The above discussion, furthermore, takes no cognizance of the fact that the service tracks on the slopes of this "soup" in the lower benches of this cut would have had to carry heavy trains on grades of 1% or more. This one consideration was, in itself, sufficient to place entirely beyond the range of possibility any question of using railroad type shovels for the removal of the whole

of the overburden in this section of the canal. In Appendix 5 attached will be found some further general discussion under this head, having to do principally with the conditions governing the choice of suitable plant for the work.

In Appendix 6 herewith is also shown a diagram outlining the procedure which would be necessary in order to remove the overburden in a typical 72 foot dry cut with railroad type shovels.

In preparing this diagram it has been assumed that the overburden is entirely dry and self supporting, so that the shovel can take out any depth of bench, and work against any height of face, within its loading range. On this basis, the 72 foot cut in question is shown to be taken out in three main benches, with the loading tracks dropping down in 9 foot steps. This diagram has no meaning at all as related to the conditions which actually obtained in the section of the canal under discussion, as it would not, under any circumstances, have been possible for the railroad type shovel to get down to the level of the first bench shown. As a matter of fact, what this diagram is meant to show is the minimum number of cuts which a railroad type shovel would be required to take, even under ideal conditions as to quality of material, and the enormous amount of moving back and track shifting which such a scheme of procedure would entail.

Flat cars with Lidgerwood unloaders are being used at the present time for disposal purposes on the Ship Canal. This procedure was adopted as a last resort by reason of the fact that the heavy clay which is being excavated will not clear the side doors of a 16-yard dump car. There was no such difficulty on

the Queenston-Chippawa work with the 20-yard cars, as this feature of the situation was foreseen when the cars were being purchased, and one of the deciding factors in favor of the Western car, as against the K. & J., was the fact that the side doors on the Western cars had a little wider dump opening. The consequence was that even with the huge blocks of solid clay which were taken out with the 8-yard dippers, in the section south of Lundy's Lane, there was no trouble in getting these fragments to clear the doors.

The contractor himself (Mr. Johnston Porter) states that ordinarily the Lidgerwood unloader has no utility whatever on a disposal area, as compared with air operated side dumping cars.

There is some further discussion of this phase of the situation in Appendix 4 attached.

PAGE 5289:

MR. HANEY - Aside from the question of wages, was the efficiency of the steam shovel men fairly well maintained?

MR. LARKIN - The actual operators, yes.

This condition also obtained on the Queenston-Chippawa work, for the simple reason that there were only about 30 to 40 shovel runners on the whole work. Such being the case, it was possible to obtain picked men and exercise close supervision over them. Taken all in all, there was never a more efficient and competent aggregation of shovel runners anywhere, but they were only 30 or 40 out of a working force ranging from about 3,000 to about 8,000 men.

PAGE 5309:

MR. FRASER - Yes, and labor went up during that job. We started with labor at $1.50 and it went to $3.50 per day (between 1915 and 1917).

In 1915 the rate for common labor in the Niagara Peninsula was $2.00 to $2.25 per day. When this work was started in the early spring of 1917, the prevailing rate for common labor was about $2.50 per day. In the 1917 estimate for the 10,000 second-foot canal, common labor was figured at $3.50 per day. This was considered a reasonable forecast at the time, as the war had then been in progress for three years, and the conditions which began to develop in the latter part of 1918, and culminated in 1920, were not conceived of or imagined.

PAGE 5311:

MR. GREGORY - Then , if you had made an estimate in 1917, would you have figured on labor at what it was at that time?

MR. FRASER - Oh, yes.

MR. GREGORY - Making some allowance for additional labor costs?

MR. FRASER - Making some allowance for possible increase.

Any sensible individual would have done the same thing at that time.

In the 1917 estimate for the Niagara work what was considered at that time a very liberal allowance was made for increased material as well as labor costs. When the work started in 1917, common labor was paid $2.50 per day, and in the estimate was figured at $3.50 per day. All plant costs were figured at or above the current prices of that date, and a large contingency item was added to cover possible future increases.

PAGE 5316:

MR. HANEY - What was the next job?

MR. FRASER - The next job of this character was the Manitoba Power plant which was started in the fall of 1921 and is not yet quite completed. They are getting power now but the rock excavation and the big dam is still to be completed, and that work is being done within the estimates.

There is no difficulty in doing work within the limits of estimates made in 1921, and our experience on this work is similar to Mr. Fraser's.

PAGE 5316:

MR. HANEY - Anyone making an estimate in 1920 should be well within their price as far as labor is concerned?

MR. FRASER - Yes. In every feature of the cost it has been reduced since 1920.

Mr. Haney's statement is true insofar as labor rates are concerned, and Mr. Fraser's statement is correct insofar as it relates to new work starting in 1920.

There was an 11% increase in labor rates in 1920 over 1919, and no decrease until August of 1921, and the intangible factor of labor inefficiency continued in full force and effect throughout this whole period. As far as other items of cost at Niagara were concerned, the Niagara job got little or no benefit from the easing-off of conditions in the latter part of 1920 and 1921, because practically all of the obligations against the Niagara work had been incurred during the peak price period.

[illegible]:

Mr. [illegible] - [illegible]?

Mr. [illegible] - The last job of this character was the [illegible] which was started in the fall of 1930 and is not yet quite completed. They are getting power now [illegible] and the [illegible] is still to be completed, and [illegible] is being done within the estimates.

There is no difficulty in doing work within the limits of estimates made in 1931, and our experience on this work is similar to Mr. [illegible]'s.

[illegible]:

Mr. [illegible] - [illegible] within their price as far as [illegible]?

Mr. [illegible] - Yes. [illegible] since 1929.

Mr. [illegible]'s statement is [illegible] and Mr. [illegible]'s statement is correct insofar as it relates to [illegible] in 1930.

There was [illegible] increase in [illegible] in 1930, and [illegible] until August of 1931, [illegible] this whole period. [illegible] from the [illegible] in the latter part of 1930 and 1931, because [illegible] during the [illegible] period.

PAGE 5316:

MR. ROSS - How do you find the efficiency of labor now as compared with before the war; is it getting back to where it was?

MR. FRASER - Oh no, they do not do as much. On the other hand, we are using machinery more than we used it before to save labor.

The condition mentioned by Mr. Fraser began to show on the Niagara work in the latter part of 1918, and became acute during the period from midsummer of 1919 until midsummer of 1921. During this period it was absolutely necessary to resort to unanticipated plant purchases to offset not only the growing inefficiency of labor, but the actual deficiency in the supply.

PAGE 5317:

MR. GREGORY - How often do you check the work?

MR. FRASER - Every month.

The same thing was done on the Niagara work, and in addition to the monthly cost reports, there was a report on the direct labor costs for earth, rock and concrete prepared every day.

Under pre-war conditions, and on a piece of work of ordinary magnitude, a monthly cost report enabled a fairly definite determination to be made as to whether estimates were being exceeded or otherwise, and served as a basis to forecast the future cost of the work. On the Niagara work the magnitude of the job alone introduced a multitude of indirect cost items and overheads which could not be seen in their true perspective in a monthly cost report. This was particularly the case on the Niagara work because working conditions were

entirely unprecedented, and were not stable from month to month, or even from day to day, so that deductions as to future progress and cost which were made according to pre-war custom, would have been very misleading; this condition, as above mentioned, being due solely to the abnormal conditions created by the war.

PAGE 5317:

MR. GREGORY - You have a program?

MR. FRASER - Yes, absolutely. We have a program and we have to sacrifice cost for program every time because time is the big element in a hydro-electric plant.

The original "program" for the Niagara work is set forth in Appendices 5 and 6 of my report of December 26th, 1917. Due to uncontrollable conditions which have been sufficiently enlarged upon elsewhere, it was impossible to adhere to this pre-arranged schedule, until August of 1920. The schedule of operations laid out in August of 1920 was adhered to within a margin of one month simply because the excavation in the quicksand section was approaching completion by that time, and because an adequate supply of labor began to become available in the early fall of 1920.

The "sacrifice" in the case of this latter program took the form of an increase in the estimated cost for the complete installation of five units to $43,000,000.00 as per the Stuart and Kerbaugh estimate. This September 1920 schedule involved practically the doing of two years' work in one to make up for the year of unavoidably lost time which occurred between the early fall of 1918 and the early fall of 1920. The recovery of this year of lost time was

necessary for two reasons; first, to meet the anticipated demand for power in the winter of 1921-22, which afterwards transpired exactly as foretold; and second, to obviate a delay of at least 12 months in pouring the concrete lining walls between the Grand Trunk Railway and Montrose, as the large amount of water in this section rendered impossible any idea of leaving the lining walls unfinished and unprotected for a winter season.

PAGE 5318:

MR. GREGORY - If you began a work and planned to have it finished at a certain time, would your object be to get as much of your plant in operation as soon as possible?

MR. FRASER - Always - and on the time feature we have not failed.

From Mr. Fraser's evidence it does not appear that he has ever been called upon to schedule a job for 3½ to 4 years ahead even before the war. Apparently the biggest job that Mr. Fraser had to schedule during the war period was the La Loutre dam, a less than two-year job which was completed in 1917, before war conditions became really acute.

The above question on the part of the Chairman would indicate a tendency to assume that the conditions which Mr. Fraser is discussing are the same as the conditions under which the work at Niagara had to be carried on. As a matter of fact, Mr. Fraser should have been asked to criticize the program of operations and working schedule set forth in Appendices 5 and 6 of my report of December 26th, 1917, as against his procedure in the case of the La Loutre dam in the same year. The circumstances which prevented this schedule from being made good were abnormal and admittedly unforeseen. The appendices above mentioned afford

sufficient evidence as to whether or not it was the intention to get the "plant in operation as soon as possible".

PAGE 5319:

MR. HANEY - Your practice is to force your work at the start and not at the finish?

MR. FRASER - Well, of course, there are a lot of small things to do at the end.

This question also carries with it an inference that through negligence or ignorance, there was not sufficient energy put into the start of the work at Niagara, and no consideration is given to the necessarily comprehensive preparatory work required for a work of such magnitude. The references made above to Appendices 5 and 6 of my report of December 26th, 1917, are also applicable in this connection.

Among a multitude of the unavoidably and justifiably unforeseen circumstances that prevented this schedule from being carried out may be mentioned the scarcity and inefficiency of labor, wet ground, defective material, the delay on the railway undercrossings, and the delay in the delivery of the first large order of construction plant, which was not considered serious at the time, but later, in conjunction with many other untoward happenings, had an appreciable influence on the result.

Appendix 7 attached covers a list of construction plant orders which have been selected to illustrate the above point. It is important to note, also, in connection with this list, that the delayed delivery shown in connection with these items took place in spite of all the assistance we could obtain from the

War Industries Board and other Government authorities. It is also to be noted that the "Date of order" on this tabulation is the date shown on the official order issued by the Purchasing Department. In the case of a great many of the items shown on the list, the article was ordered on specifications of the Engineering Department and the manufacturer sometimes got the order several weeks before the official confirming order of the Purchasing Department was issued. For instance, in the case of the large shovel and dump car order given to the Canadian Equipment Company, this was placed about the middle of December, 1916, subject to cancellation in one month. This order was given simply to hold the price, and was confirmed on January 15th, 1917, being the same day that the purchase was authorized by the Commission.

PAGE 5320:

> MR. GREGORY - Have you any estimate of the cost of your plant as compared with the total cost of your work?
>
> MR. FRASER - On the Manitoba job, the total cost was $8,000,000.00. The part that we had cost nearly $3,500,000.00. That leaves out the permanent equipment and leaves out the cement. We had from $450,000.00 to $500,000.00 worth of contractor's plant on the job.

The above question and answer, and the subsequent discussion under the same head, has no significance whatever as related to the items classed as "plant" on this work.

In Appendix 8 attached is a list of items which would cover the "contractor's plant" used on this work, that is, $9,804,732.00 worth of plant, which was and is to be used to do $64,761,660.00 worth of construction work. In other words, the cost of the contractor's plant on this work was 15% of the work

accomplished and still to be done. This percentage includes all the abnormal wartime conditions, including exchange, war-tax, extra freight, etc., connected with its purchase, use and final disposition. Under the circumstances, this percentage compares favorably with the 13% to 15% mentioned by Mr. Fraser in connection with the Manitoba Power Company work, which was estimated on, and planted, under comparatively stable conditions.

As a matter of fact, the percentage of plant investment on this work would normally be much less than on any work Mr. Fraser has been connected with, owing to the concentration of large production capacity in single units of plant such as the big shovels, the primary crusher and the dredge "Cyclone". If the Niagara plant equipment had been bought under conditions similar to that of Mr. Fraser's plant, the percentage would have been below 10%, as against Mr. Fraser's 13% to 15%.

PAGE 5322:

MR. HANEY - If you had four years to do a job, could you do it cheaper than if you had to do it in two years?

MR. FRASER - Yes, if it was a fairly big job, the indirect cost would be less. The indirect cost of a two year job would run 40%, and on a four year job would be much less.

This statement is premised altogether upon the assumption that conditions governing cost and progress remain reasonably normal and constant during the period between the date of the preparation of estimates and working schedule, and the date of final completion of the work. It is quite needless to comment upon the extent to which this condition failed to materialize on the Niagara

work. Obviously there must be a point at which an extended term of completion balances the reduced overheads, and this point will vary with every job, according to the magnitude and the classes and nature of work involved.

PAGE 5323:

MR. HANEY - Are the men inclined to shirk their work at night more than they do in the day-time?

MR. FRASER - I do not think it is conscious shirking, the men are not in as good trim at night as they are in the day-time. The conditions are against them. If it is raining and if you have good camps for the men, you can get a good deal done in wet weather during the day-time, but on a wet and stormy night it is almost impossible to get work done.

COPY

What Mr. Fraser says is correct. One outstanding condition under this head, which was met with on the Niagara work, and which possibly did not come very prominently before Mr. Fraser's notice, was the immense traffic in illicit liquor with which this work was surrounded from the time the Wartime Temperance Act went into force until the main body of the construction work was completed in the fall of 1921. This situation was particularly serious on the night shift, and made its influence felt in all phases of the work, including railway operations, injury to plant, bodily injury, and a variety of other ways which constant watchfulness was unable wholly to prevent.

PAGE 5323:

MR. HANEY - If you were not pinched you would not put on a night shift?

MR. FRASER - No, but very often in drilling and rock work it can be done at night so as to keep it ahead.

The disadvantages of night shift work were fully realized at the start of the work, and the only regular night shift work contemplated was the rock drilling and channeling operations, which could be done more efficiently at night for two reasons; first, because it improved the load factor on the sub-station and upon the compressed air supply; and, second, because it eliminated interference with blasting operations, and because a comparatively small force of more or less expert workmen would be required, thus making continuous and efficient supervision possible.

PAGE 5325:

MR. R. A. ROSS - The cost is nearly 5 to 1?

MR. FRASER - All of that.

The above observations were probably wrongly reported by the stenographer.

HR, chapter H, page 98, shows a direct comparison of the relative cost of electric and steam shovels. Electric shovel No. 6 cost $15,732.00, and steam shovel No. 5, of the same type and make, cost $10,805.00. The electric shovel therefore cost about 45% more than the steam shovel of the same type.

The tabulation in Appendix 9 attached, shows the comparative costs of the larger sizes of similar types of electric and steam shovels, and indicates that the cost of electric shovels, as compared with steam, is in the ratio of somewhat less than 1½ to 1.

PAGE 5325:

MR. R. A. ROSS - Is the increased efficiency of the electric shovel more than counterbalanced by the increased cost?

MR. FRASER - The investment is too great for us and we never tried one.

The reason Mr. Fraser has never used an electric shovel is because he has never handled a piece of work large enough to justify, in his opinion, the increased cost. As a matter of fact, the use of electric shovels would have been justified on his first contract at the Cedars Development, but as electric shovels were more or less of an innovation in 1915, he probably never gave the matter any consideration at all, either from the economic or practical side.

In Appendix 10 attached are some comparative figures of the economics of similar types of electric and steam shovels operating in earth, together with a direct comparison made in 1921, when the Bucyrus 225-B steam shovel was operating in close proximity to the 225-B electrics in both earth and rock, and under fairly similar working conditions, except height of lift. These records are authentic, and show conclusively that the greater efficiency of the electric shovel offsets by a large margin the increased cost of this shovel, as compared with the steam shovel of similar type.

PAGE 5325:

MR. R. A. ROSS - What would you say to the type of steam shovel used by the Hydro?

MR. FRASER - Here is a 65 ton shovel, 2½ yard bucket, that cost $9,000.00. That was bought in September, 1917; that was a very low price. Electric shovels about the same weight cost $15,000.00.

An electric shovel of the same type as the Atlantic shovel above referred

to would cost not less than $30,000.00.

This particular Atlantic shovel was rented in May, 1917 from Stein and Reid, sub-contractors on the Welland Canal. This shovel was rented on account of the impossibility of getting prompt delivery on new equipment, the object being to "force the work at the start" in accordance with the program laid down in Appendices 5 and 6 of my report of December 26th, 1917. Furthermore, this purchase price of $9,000.00 included 7 - 6 yard dump cars, the owners having got tied up in a coal stripping proposition in New Brunswick, and being in urgent need of working capital. The whole outfit was therefore taken over at a bargain price of $9,000.00 with all rental payments allowed to date of purchase.

If this shovel had been bought new, at that time, it would have cost not less than $20,000.00, exclusive of the dump cars which were thrown in with it.

PAGE 5325:

MR. HANEY - You do not know whether in actual operation a 70-ton electric shovel would take any more earth or swing any oftener than a steam shovel?

MR. FRASER - I do not know.

There is no definite relationship between swing cycle and production when comparing electric and steam shovels. The steam shovel will always swing more times per minute, but on the other hand, the electric shovel will always swing more times per day, per week, or per month.

PAGE 5326:

MR. HANEY - Do you know how many swings per minute you can get out of a steam shovel?

MR. FRASER - No, I carry it in yards per day rather than swings.

Mr. Fraser is right, but he should go one step further, and carry it in yards per month. The busiest looking and fastest swinging shovel on the job may be dumping a half-filled dipper most of the time, while a comparatively sluggish looking shovel beside it may be lifting an extra half yard of material on the dipper teeth at every swing.

Under such circumstances, the only basis of comparison is the engineers' return at the end of the month. A fast swing has no significance whatever by itself.

PAGE 5327:

> MR. HANEY - They might have taken practically the whole of the material to St. Davids, and that would be on a downgrade. The advantage of taking it to St. Davids was that it was downgrade, whereas the disposal area opposite mile post 2 was on a 1% upgrade. It was all on a temporary trestle.

A glance at FE, chapter H, pages 53 and 54, is sufficient to demonstrate the error of the above statements, as related to the proposal to eliminate the Lundy's Lane disposal area, and dump all the excavated material at St. Davids. In the first place, this proposition would have involved a minimum extra haul of 5½ miles for all material south of mile post 2. Also, in this 5½ miles, there would have been 5,000 feet of .86% grade against loaded traffic on the main line, and 8,000 feet of 1% grade against loaded traffic on the St. Davids disposal spur. In other words, there is nearly 2½ miles of grade approximating 1% against loaded traffic between mile post 2 and the St. Davids disposal. As against this, there is only 1,000 feet of grade approximating 1% against loaded

traffic between mile post 2 and the Lundy's Lane disposal area, and the total length of haul from mile post 2 to the Lundy's Lane disposal is only 2,500 feet, as against 5½ miles to St. Davids.

The only trestle on the Lundy's Lane disposal spur was a 30 foot crossing of the Welland Road.

If the 6500 second-foot scheme had been carried out without any enlargements and under 1917 conditions, the Lundy's Lane disposal area would probably never have been developed.

PAGE 5328:

MR. HANEY - The question is, the method that you would adopt to take this excavation out in three years; that is, 9,000,000 yards of earth, overlying 4,000,000 yards of rock.

The possibility of taking out 9,000,000 yards of earth and 4,000,000 yards of rock in three years was never at any time considered as even a remote possibility. The three years mentioned by the Chief Engineer in his memorandum to the Commission under date of January 11th, 1917, was a preliminary estimate only, and not a worked out schedule similar to that included in my report of December 26th, 1917. This three year estimate furthermore, involved in all a total of 9,603,070 yards only, made up of 7,036,090 yards of earth and 2,576,980 yards of rock, or 26% less work than Mr. Fraser was given to understand that we intended to do in the three years' time. Furthermore, 1,125,000 yards of the above total of earth yardage was in the earth section of the canal at Montrose which, at the time of the Chief Engineer's memorandum to the Commission, was intended to be dredged, and not excavated in the dry, resulting in a yardage actually 36% less than Mr. Fraser understood was to be taken out in the dry.

The above information is all obtainable from FR, chapter K, appendix 1-A, et seq.

PAGE 5328:

> MR. HANEY - What would you do as a contractor on the question of the practicability of these large units? I do not think they are economical or practical.
>
> MR. FRASER - Well, in the canal work the expense of climbing out of the canal is a very large one, and these machines, which would land the material away up on the bank, look very good to avoid these inclines for climbing out, if it is soft ground and slippery.

Mr. Fraser has fairly well summarized the whole situation in his reply to the above question, and a little elementary arithmetic is all that is necessary to prove Mr. Fraser's point for the large units, as against Mr. Haney's scheme for small railroad type shovels and long trains.

The total maximum lift of the 70 ton shovel is 17 feet, and the total maximum lift of the 225-B shovel is 80 feet. With ten small shovels working in series, the track system necessary to give adequate service to each shovel would obviously require frequent ramping out of the cut. Such being the case, the excavated material would have to be lifted out of the cut in the vicinity of the point from which it was excavated. The point at issue is, therefore, whether the material should be lifted the whole distance with the shovel, or whether it should be lifted 17 feet with the shovel, and the balance of 63 feet with trains.

For instance, from Station 205 to Station 235, and from Station 335 to Station 355, the overburden was of such a depth that the maximum lifting range

of the big shovels had to be utilized, so that in this section the whole of the 63 feet of excess lifting range of the big shovels over the small shovels was effective, as against the absorption of this extra lift by train service.

The absorption of this maximum extra lift of 63 feet by 25-car trains, and 30 yard cars, operating on 1/2% grade, would necessitate a train haul of 2.4 miles per train over a complicated and unwieldy system of tail-track. In other words, every yard of material excavated by these shovels would have to spend anything up to one hour on bad track and soft ground before being lifted into the clear, and headed for the disposal area. The big shovels accomplished this same end in a few seconds and landed the material directly onto firm, ballasted, permanent track.

Some data bearing on the question as to whether or not these large shovels are "economic or practical" is obtainable from an intelligent perusal of Mr. Goodwin's report on excavation methods and equipment.

Apparently as long ago as 1916, these shovels were in effective use on construction work similar to that at Niagara, and everyone familiar with modern methods of handling this class of work knows that the use of these large shovels is becoming standard practice on stripping work, where faces ranging upwards from 30 ft. are involved.

The shops of the Bucyrus and Marion Companies are glutted with orders for these shovels, placed by iron, copper and coal mining companies all over North and South America. Large numbers of these shovels are, furthermore, electrically driven, although the Niagara work was possibly the pioneer enterprise in this connection.

PAGE 5328:

MR. HANEY - You have practically 9 miles where you do not have to climb out, and with a very large percentage of the rock there is no climb at all.

MR. FRASER - Don't you have some climb?

This statement is hard to understand. Possibly the idea in this connection would be to start at the Lundy's Lane summit, and work both ways from the summit, taking out parallel cuts on a self-draining grade. This procedure would unavoidably involve an immense amount of moving back, and a wilderness of loading and disposal tracks which would have to follow the shovels down to within 10 ft. of the rock surface wherever it might occur.

If there were no "climbing out" the disposal tracks would have to parallel the loading tracks in the bottom of the cut as it went down, and would involve the continuous shifting of a continuously and enormously increasing mileage of track, the gradient of which on the last bench would be governed, not by the grade of the shovel, but by the natural gradient of the rock.

The one all-sufficient reason why such a scheme would be absolutely impossible is because of the often-repeated statement that the bottom would hold neither the small shovels nor their service track, a fact which was apparent when the original borings were made, and which was one of the controlling factors involved in the decision to use the large shovels. Among other reasons why this scheme would be impossible, the following may be mentioned offhand:

(a) - With all the shovel capacity concentrated on stripping operations, it would have been impossible to provide ballast for track systems and roads.

(b) - It would have been impossible to put in temporary trestle diversions on the railroads and main highways, because each succeeding series of shovel

cuts would destroy the foundations.

(c) - It would have been impossible to build the permanent railroad or highway bridges until the earth and rock work in the canal was finished, because there would not have been room beneath them for the track systems which would have been necessary for handling the excavated material without "climbing out".

(d) - It would have been impossible to build the big rock fill at Bowman's Gully in time to allow a sufficient period for settlement, before placing the concrete lining and filling with water.

(e) - The unrestricted free drainage north and south from Lundy's Lane would have gorged such natural waterways as DeWitt's Creek, Galley's Creek, and Muddy Run with silt, and in the latter instance would have damaged the sewage system of Niagara Falls.

As to the statement that "a very large percentage of the rock there is no climb at all" a glance at the profile in FR, chapter H, page 31, shows that the rock section of the canal is essentially a hole, 8 miles long, 50 ft. deep at the forebay, 85 ft. deep in the middle, and 60 ft. deep at the Montrose end. It is difficult to imagine how "a very large percentage" of this rock could be removed with small shovels without "climbing out". As a matter of fact, it is only necessary to look at the cross section of the rock cut, and some of the pictures of the completed excavation, to realize how utterly impossible it would be to take out this rock at all with a 70 ton shovel, owing to the absolute lack of sufficient working room for the proper co-relation of shovel, train service, blasting, and drilling operations. Furthermore,

which would destroy the foundations.

(b) - It would have been impossible to build the permanent railroad or highway bridges until the earth and rock work in the canal was finished, because there would not have been room beneath them for the [illegible] trestles which would have been necessary for handling the excavated material without rehandling it.

(c) - It would have been impossible to build the dry rock fill at Hamner's Gully in time to allow a sufficient period for settlement, before placing the concrete lining and filling with water.

(d) - The construction [illegible] north and south from Lundy's Lane would have [illegible] Bailey's Creek, and [illegible] with silt, and in the latter instance would have damaged the sewage system of Niagara Falls.

As to the statement that "a very large percentage of the rock there is [illegible] of silt" a glance at the profile in [illegible], page 7[illegible], shows that the rock section of the canal is practically a ditch 4 miles long, 30 ft. deep at the [illegible], [illegible] ft. deep in the middle, and [illegible] ft. deep at the north end. It is difficult to imagine how "a very large percentage" of this rock could be [illegible] without "[illegible]". As a matter of fact, it is only necessary to look at the cross section of the rock cut, and some of the pictures of the completed excavation, to realize how utterly impossible it would be to [illegible] the absolute lack of sufficient working room for the proper [illegible] drill, [illegible], blasting, and drilling operations. Furthermore,

draglines would have been useless on this work, and the only other possible method of moving this rock, below the first 10 ft. bench, would have been by means of derricks and skips.

PAGE 5329:

MR. FRASER - What output did the shovels actually get per month?

MR. HANEY - I think with these big shovels they got as high as 70,000 yards per month on a 10 hour shift.

MR. FRASER - That is a small output for that class of shovel. We have under similar conditions taken out 45,000 yards of clay in a 10 hour shift with a 70 ton Bucyrus shovel.

Apparently, the only place where "similar conditions" would apply is in the case of No. 11 shovel in the heavy clay in the vicinity of the Convent Road. No. 11 shovel worked for five consecutive months in this material before going into rock in July of 1921. The average for the five months was 76,700 yards per month, and the maximum month's work was 94,500 yards on a 10 hour day shift basis, with a 30 ft. lift. In August 1919, No. 8 shovel, working in quicksand near Victoria Street, took out 90,500 yards on the 10 hour day shift, with a 70 ft. lift. The railroad type electric shovels on the Niagara work got "as high as" 66,500 yards in one month of 10 hour day shift, with a 10 ft. lift. In passing, the above figures may be instanced as another proof of the production superiority of electric shovels over steam.

PAGE 5330:

MR. FRASER - I would not estimate the shovels in earth at more than 40,000 yards per month - that is, assuming that you have a dry bottom and good train service, and nothing that requires blasting or shaking up in any way.

Mentioning dry bottom, Mr. Fraser has prescribed a condition which did not exist at Niagara. This fact has been repeatedly mentioned heretofore, and is not susceptible of contradiction in the slightest degree, and definitely decides the merit of any scheme involving the removal of any such average as 40,000 yards per month with railroad type shovels.

PAGE 5330:

> MR. HANEY - They found at the surface of the rock some quicksand. I happened to be there and saw the operation at the point where they had some trouble in that way. They had to work their shovels on pontoons. By taking off this earth first they would have had drainage.

> MR. FRASER - Some soils will not drain sufficiently so that you will have a good bottom that you can work with a steam shovel on it.

Quicksand was not found at the surface of the rock. Most of the borings showed a thin layer of fine gravel at the surface of the rock with the saturated sands above. It was the existence of this thin gravel seam on the surface of the rock which led us to expect that the ground water would drain out through it when the cut was opened up, and thus provide reasonably dry digging. The ground water did actually behave more or less as anticipated, but throughout the whole distance between the Grand Trunk bridge and Lundy's Lane, the lower stratum of earth was kept continuously saturated by heavy springs which discharged upwards through fissures in the solid rock. The existence of these springs had more to do with the failure of the shovels to realize their anticipated production than any other single factor.

The inference from Mr. Haney's above statement is that the shovels were working on pontoons on account of the quicksand. The quicksand had nothing to do with the use of the pontoons, as the shovels were working from the rock.

The pontoons were simply a convenient method of lining up the bridle rail for moving the shovel ahead, and they were used for no other purpose.

PAGE 5330:

MR. FRASER - Can you give the output for a year of one of the big shovels?

MR. FRANCIS - Shovel No. 1 in 1918 did half a million yards.

No. 1 shovel did not get to work until April of 1918, and lost nearly two subsequent months of that year, in the best working season, with mechanical and electrical trouble for which the manufacturers were responsible and made good. No. 1 shovel was the first large shovel placed in service, and these difficulties were remedied before the other shovels of the same type were placed in service. The record mentioned by Mr. Francis would, therefore, only apply to about six months of normally continuous operation.

As a matter of fact, the original working schedule was so disrupted by the scarcity of labor, labor troubles, and other unavoidable and unforeseen conditions arising out of the war, that not one of the large shovels had a normally continuous year's work in earth. No. 8 had the nearest approximation to a year's normal work in 1920, in which year she removed 1,002,738 yards, but this figure is far from being a fair measure of the capacity of the shovel, owing to the fact that the strike occurred in this year, and for the bulk of the time she was working in quicksand and baling out nothing but liquid mud for months at a time.

The nearest approach to a normal production record for one of these big shovels was that of No. 11 previously mentioned, for the months February to June,

[illegible]

[illegible]:

[illegible] - [illegible] big shovels?

[illegible] - Shovel No. 1 in 1918 did half a million yards.

No. 1 shovel did not get to work until April of 1918, and lost nearly [illegible] months of that year, [illegible] mechanical and electrical trouble, for which the manufacturers were responsible and made good. No. 1 shovel was the first [illegible] placed in service, and these difficulties were remedied before the other shovels of the same type were placed in service. The record mentioned by [illegible], therefore, only apply to about six months of actually continuous operation.

As a matter of fact, the original working schedule was so disrupted by the scarcity of labor, labor troubles, and other uncertainties and [illegible] conditions arising out of the war, that not one of the large shovels had a normally continuous year's work in [illegible]. No. 2 had the nearest approximation to a year's normal work in 1920, in which year she removed [illegible] yards, but this figure is far from being a fair measure of the capacity of the shovel, owing to the fact that the strike occurred in this year, and [illegible] months at a time.

The nearest approach to a normal [illegible] shovels was that of No. [illegible] previously mentioned, for the [illegible]

inclusive. The maximum month's output for this shovel during the above period was 186,310 yards, and the average output for the five months was 151,463 yards. On the basis of this average output, the year's production would have been 1,817,556 yards. The material in this case was the heaviest kind of clay on a face averaging 26 feet in height, loading tracks about 30 feet above shovel grade, and the cut bottoming about 103 feet in width. The face was also fairly dry, but even here the material was so unstable that the loading tracks had to be carried on trestle, and shovel operations had to be interrupted so as to allow rip-rap to be dumped on the slopes on a line with the front trucks of the shovel, in order to hold the material in place.

Some further discussion as to conditions affecting the shovel schedule and the shovel production will be found in Appendix 11 attached.

PAGE 6331:

MR. FRASER - What was the width of the cut?

MR. FRANCIS - It would probably be 70 ft. at the tow of the cut.

The theoretical width of the bottom of the earth cut was 70 ft., but owing to the ultimately ascertained necessity of providing a heavy rip-rap fill throughout practically the whole length of the canal, to hold the unstable material in the slopes, the bottom width of the earth cut was taken out to the varying widths necessary for such base thickness of rip-rap filling as was considered necessary to hold the slope. For this reason the bottom width of the cut was sometimes as much as 110 feet, and averaged nearly 90 feet.

Louisiana. The maximum month's output for this shovel during the same period was 185,816 yards, and the average output for the five months was 151,588 yards. On the basis of this average output, the year's production would have been 1,817,000 yards. The material in this case was the heaviest kind of clay on a bank averaging 46 feet in height, leaving stakes about 22 feet above normal grade, and the cut averaging about 125 feet in width. The face was also fairly dry, but even here the material was so unstable that the loading tracks had to be carried on trestle, and several operations had to be interrupted so as to allow rip-rap to be dumped on the slopes at a line with the front tracks of the shovel, in order to hold the material in place.

Some further discussion of the conditions affecting the shovel schedule and the shovel production will be found in Appendix II attached.

CUT WIDTH.

Mr. Francis - What was the width of the cut?

Mr. Godwin - It would generally be 72 ft. at the toe of the cut.

The theoretical width of the bottom of the earth cut was 72 ft., but owing to the ultimately ascertained necessity of providing a heavy rip-rap fill throughout practically the whole length of the canal, to hold the unstable material in the slopes, the bottom width of the earth cut was increased by the varying widths necessary for said rock blankets or rip-rap filling as was considered necessary to hold the slopes. For this reason the bottom width of the cut was sometimes as much as 150 feet, and averaged nearly 90 feet.

PAGE 5331:

MR. FRASER - I have no figure in my mind as to what proportion of the 9,000,000 yards would be in 30 ft. cuts; would there be 25% of it?

MR. HANEY - I do not think so.

Mr. Fraser, in asking this question, mentions a depth of cut which he presumably considers is the maximum depth at which a 70 ton shovel can operate safely and efficiently. He also apparently has in mind the idea that the large shovels would not be necessary if less than 25% of the 9,000,000 yards was in cuts of 30 ft. depth or more. Mr. Haney's assurance that there was not 25% of the total yardage in 30 ft. cuts would be the controlling factor in his reasoning under this head. As a matter of fact, a glance at the profiles, FR, chapter H, page 131, is sufficient to indicate that south of station 368, the total yardage of overburden is in 30 ft. cuts or more.

South of Station 368 the average depth of cut is 47 feet, and the maximum 74 feet. From Station 120 to 280, a distance of 3 miles, the average depth of cut is 49 feet, and the maximum 65 feet.

South of Station 368, the yardage of overburden removed was 9,580,000 yards and north of Station 368, where the cut was 30 ft. or less, the yardage removed was only 217,000 yards.

In other words, there was 98½% of the total earth yardage in cuts averaging 47 ft. in depth, and only 1½% of the overburden was in cuts up to a maximum depth of 30 ft.

This one misconception alone is sufficient to destroy the significance of Mr. Fraser's whole argument for the small shovels.

PAGE 5332:

MR. HANEY - Do you consider that Lundy's Lane would be the point where this work should be forced, and attack that point as quickly as possible?

MR. FRASER - With ordinary shovels, yes; but when you are planning to buy shovels to take that out in one cut might be different. Your big shovel had to have two lifts there for a distance of two miles. I think I might have started an independent operation there. Did they do that?

MR. HANEY - No, they did not reach that until March, 1921.

Mr. Haney's statement is not correct. An "independent operation" was started at Lundy's Lane with "ordinary shovels", precisely as Mr. Fraser prescribes, in September of 1919.

Mr. Fraser is quite right in stating that this summit cut could not have been taken out in one lift with the big shovels, and it was never the intention to do so. The main objective of the construction railway southward was to connect the summit with the disposal area at the earliest possible date, so as to start this "independent operation" with small shovels, and "force" the work at this point.

The attached blueprint, Appendix 12, shows that the construction railway reached Lundy's Lane in September of 1919, and the shovel records show that excavation started on the summit immediately, after the completion of single track construction to this point.

Mr. Haney tells Mr. Fraser that we did not start "an independent operation" at this point, and did not reach that point until March of 1921. As a matter of fact, by March, 1921, a total of 2,600,000 yards of material had been taken off the summit in the two mile stretch mentioned by Mr. Fraser.

PAGE 5332:

MR. GREGORY - They planned to do the work within three years.

The work described to and discussed with Mr. Fraser was never at any time planned to be completed within three years.

PAGE 5333:

MR. GREGORY - They set out to build this canal at the same size it was built.

MR. FRANCIS - In the second plan they largely increased the size of the canal.

MR. GREGORY - They reported to the Government that they would be able to do it in three years, and they planned accordingly, and it was a canal of the same size.

Mr. Gregory's statements are in error. The canal which it was estimated would take a proximately three years to build was never built. Further down on this same page Mr. Fraser attempts to outline his method of procedure on the basis of this supposed three year schedule. What he says is meaningless, because the data given him as a basis for his reasoning was wrong.

PAGE 5333:

MR. FRASER - It is unusual, it is away beyond anything else that has been done, to do 13 miles of canal in three years.

13 miles of canal was never a factor, either in the three year estimate, or even in the actual schedule outlined in my report of December 26th, 1917, simply by reason of the fact that the placing in operation of the first two

PAGE [illegible]:

MR. GREGORY - They planned it to fit with their [illegible].

The work described to and discussed with Mr. Tenner the summary of the line planned to be completed within three years.

PAGE [illegible]:

MR. GREGORY - They set out to build this canal of the size it was built.

MR. TENNER - In the second place they largely increased the size of the canal.

MR. GREGORY - They reported to the Government that they would be able to do it [illegible], and they planned accordingly, and it was a canal of the same size.

COPY

Mr. Gregory's statements are in error. The canal which it was estimated would take approximately three years to build was never built. Further down on this same page Mr. Tenner attempts to explain the method of procedure on the basis of this planned three year schedule. What he says is meaningless, because the data given him as a basis for his testimony was wrong.

PAGE [illegible]:

MR. TENNER - It is unusual, it is away beyond anything else that has been done, to do 15 miles of canal in three years.

15 miles of canal was merely a factor, either in the three year estimate, or even in the actual schedule outlined in my report of December 5th, 1947, simply by reason of the fact that the planning is dependent on the first on-

units did not involve the expenditure of a single dollar, or a single hand's turn of work, beyond the junction of the Welland River and the earth section of the canal at Montrose, or only about 8½ miles in all.

PAGE 5334:

> MR. HANEY - To serve a steam shovel, drill or hoist irrespective of efficiency, would it take any more men?
>
> MR. FRASER - The same number of men will serve a steam shovel as formerly, but it takes many more on the dump.

Mr. Fraser's statement may be true at the present time as regards steam shovel operation, but on the Niagara work, from the spring of 1919 on, it usually took twice the normal number of pitmen to serve a shovel. On the Calumet Sag work a Model 300 Marion only used 2 pitmen. On the Niagara work we were forced, by labor conditions, to use 8.

PAGE 5338:

> MR. BOWER - They used half a million barrels of cement on the job in four years.
>
> MR. FRASER - In thqt case they were not using cement any faster than we were.

Mr. Bower's statement was made in ignorance, and gave Mr. Fraser a wrong impression as to the rate at which cement was used, and had to be used, on the Niagara work.

Up to September, 1920, only 38,700 barrels of cement had been delivered and used, as the only concrete work which was done, or could be done, up to that time, was on the bridges and in the foundations of temporary buildings.

[illegible]

[illegible]

[illegible] of efficiency, would it take any more men?

[illegible]

[illegible] serve a shovel. On the [illegible]

we were forced, by labor conditions, to use 8.

[illegible] They used half a million barrels of cement on the job in [illegible].

[illegible] then we were.

[illegible] Niagara work.

[illegible]

Between September 1920 and the end of November 1921, a period of 13 months, 444,242 barrels of cement were delivered and used, the average rate of use being over 34,000 barrels per month, or at the rate of 410,000 barrels per year.

PAGE 5340:

MR. RANEY - What would the cost of taking out granite be as compared with taking out the rock at Chippawa?

MR. FRASER - The Chippawa rock would be much cheaper, it is limestone and some shale. We worked in shale at one time and we did not have to sharpen our tools at all.

Of the total yardage of rock taken out at Niagara, only 226,000 yards, or 5.2%, was shale. The balance was limestone of varying degrees of hardness and workability. North of Bowman's Gully it was of even texture and easily worked, but south of Bowman's Gully it was very hard to handle, and some of it was harder to handle than granite, owing to its toughness and the way in which it broke with shooting.

PAGE 5345:

MR. GREGORY - If the Hydro Commission had called you in before they began their construction work and told you the time in which they wished to do it, could you have given them a working plan by which they could have finished it in time?

MR. FRASER - Oh, yes. We have not failed in any power jobs, and they are quite comparable. We had 8 shovels working at one time in Cedars and I think 10 ordinary shovels would have done the earth work at Chippawa. It would require another batch of shovels to do the rock, or the earth shovels might have been used for the rock work later.

Between September 19[illegible] and the end of November 19[illegible], a period of [illegible] months, regular supply of cement were delivered and used, the average rate of use being over [illegible] barrels per month, or at the rate of [illegible] barrels per year.

LATER READ:

MR. [illegible] - What would the cost of taking out granite be as compared with taking out the rock at Chippewa?

MR. FRANCIS - The Chippewa rock would be much cheaper, it is limestone and some shale. We worked it chiefly at one time and we did not have to sharpen any tools at all.

Of the total yardage of rock excavated at Chippewa, only [illegible] yards, or [illegible]%, was shale. The balance was limestone of varying degrees of hardness and workability. North of Newman's Gully it was of some hardness and readily worked, but south of Newman's Gully it was very hard to handle, and some of it was harder to handle than granite, owing to its toughness and the way in which it broke with shooting.

LATER READ:

MR. [illegible] - If the Hydro Commission had called you in before they began their construction work and told you the time in which they wished to do it, would you have given them a working plan by which they could have finished it in time?

MR. FRANCIS - No, sir. We have not failed in any great area, and they are quite cooperative. We had [illegible] shovels working at one time in [illegible] and I think if sufficient notice would have been the earth work at Chippewa, it would require another number of shovels to do the rock, or the earth shovels might have been used for the rock work later.

In considering this reply of Mr. Fraser's it must be borne in mind that by his own admission, he has never at any time been nearer to the Niagara work than Toronto, and also that he is basing the above opinions upon the erroneous data which was given to him.

The practicability of using railroad type shovels for the rock work has been referred to previously.

From the above statement, Mr. Fraser apparently bases his ability to do the Niagara work with 10 ordinary shovels on the fact that he had 8 shovels working at one time on the Cedars job. It would be interesting to compare the monthly output of Mr. Fraser's 8 shovels at Cedars with the monthly output of the 9 regular shovels working at Niagara in the fall and spring of 1921. For instance, in March of 1921, these 9 shovels took out 350,283 yards of earth and 231,016 yards of rock, or a grand total of 581,299 yards for the month. Even <u>previous</u> to the spring of 1920, through the worst period of labor trouble, inefficiency, and other war conditions, the 7 regular excavating units then in commission <u>averaged</u> 343,000 yards of earth and rock per month. Mr. Fraser should be given these figures to think over before he schedules his "10 ordinary shovels" to take out the earth and rock at Niagara.

<u>PAGE 5346</u>:

<u>MR. HARRIS</u> - If you had an estimate in 1917 on a job, and if you knew the conditions that existed, and if you had estimated in the beginning of the year that job would cost $13,000,000, and at the end of the year you revised the estimate and made it practically double that, and if you then said - "this takes in everything and is absolutely safe", and then when you completed you found you were 200% above that figure, what would you think of yourself as an engineer?

In considering this reply of Mr. Fraser's it must be borne in mind that by his own admission, he has never at any time been nearer to the Niagara work than Toronto, and also that he is basing his whole opinion upon the [illegible] data which was given to him.

The practicability of using railroad type shovels for this work has been referred to previously.

From his above statement, Mr. Fraser apparently bases his ability to do the Niagara work with 10 ordinary shovels on the fact that he had 8 shovels working at one time on the Cedars job. It would be interesting to compare the monthly output of Mr. Fraser's 8 shovels at Cedars with the monthly output of the 9 regular shovels used at Niagara in the fall and spring of 1921. For instance, in March of 1921, these 9 shovels took out [illegible] yards of earth and [illegible] yards of rock, or a grand total of [illegible] yards for the month. From [illegible] in the spring of 1920, through the worst period of labor troubles, inefficiency, and other war conditions, the 7 regular excavating units then in operation averaged 243,000 yards of earth and rock per month. Mr. Fraser should be given these figures to think over before he expresses his "10 ordinary shovels" to take out the earth and rock at Niagara.

PAGE [illegible]:

Q. [illegible] - If you had an estimate [illegible] on a job and if you [illegible] the conditions that existed, and if you had estimated in the beginning of the year that job would cost [illegible], and at the end of the year you revised the estimate and made it practically double that, and if you then said - "this takes in everything and is absolutely safe", and then when you completed you found you were more than that figure, what would you think of yourself as an engineer?

MR. FRASER - I do not know. We did not do this job and jobs are all different. Generalities are one thing and what another fellow should have done is not fair to ask of us.

The question asked was entirely misleading. Never having seen the work and knowing nothing of its history, Mr. Fraser's answer was obviously the only one he could have made.

PAGE 5346:

MR. FRASER - I would suggest that the preliminary estimates must have been too low, the increase in cost of doing the work did not account for all that difference. The prices for the Welland Canal work were too low. I made an estimate on the work, and I consider that the prices at which the work was let were too low.

As Mr. Harris put his original question, the only inference Mr. Fraser could possibly make was that the preliminary estimates were too low, simply because Mr. Harris gave him to understand that the work as it now stands, cost four times what it was originally estimated to cost. The increase in the cost of work certainly did not account for all that difference.

It seems hardly necessary to pursue this argument further.

As to the prices for work on the Welland Canal, it may be worth while to mention that they were high enough to allow most of the sub-contractors to make money. This statement is not based on rumor, but on fact.

PAGE 5347:

MR. HANEY - They estimated that the rock cutting would cost 85¢ per yard in 1917.

MR. FRASER - I do not know. We did not do this job and jobs are all different. Specifications are one thing and what another fellow should have done is not fair to ask of us.

The question asked was [illegible] Mr. Fraser's answer was obviously the only one he could have made.

[illegible]:

MR. [illegible] - I would suggest that the preliminary estimates must have been [illegible], the increase in cost of doing the work did not account for all that difference. The prices for the Welland Canal work were too low. I made an estimate of the work, and I consider the prices at which the work was let were too low.

As Mr. Harris put his original question, the only inference Mr. Fraser could possibly make was that the preliminary estimates were too low simply because Mr. Harris gave him to understand that the work as it was finally cost [illegible] times what it was originally estimated to cost. The increase in the cost of work certainly did not account for all that difference.

It seems hardly necessary to pursue this argument further.

As to the prices for work on the Welland Canal, it may be worth while to mention that they were high enough to allow each of the sub-contractors to make money. This statement is not based on rumor, but on fact.

[illegible]:

MR. [illegible] - That estimated that the canal would cost [illegible] than it did.

MR. FRASER - That was too low.

MR. HANEY - And that the earth excavation would cost 26¢.

MR. FRASER - That was too low. I would say from my experience that it would be quite impossible to do either of these things at that date.

The cost of rock at Niagara was never at any time, or under any circumstances, estimated to cost 85¢ per yard.

In 1917 the minimum net cost of earth and rock was estimated at 26½¢ and 97¼¢ respectively, and it is only fair to observe further that in my report of December 26th, 1917, Appendix 7, the possible maximum cost of earth and rock was estimated to be 33⅓¢ per yard and $1.21½ per yard respectively. These costs were on the basis of electric operation and, of course, would not come within Mr. Fraser's "experience". The price coming within Mr. Fraser's experience was the estimated cost of earth with steam operated equipment, as set forth in Appendix 8 of my report above mentioned; namely 53.6¢ per yard, or 61% higher than the estimated cost with electric operated plant. Applying this same percentage of increase to the estimated rock cost of $1.21 per yard, we get $1.95 per yard for rock with steam operated equipment, which figure agrees reasonably well with Mr. Fraser's estimated cost of $2.00 per yard.

PAGE 5347:

MR. HANEY - What would you have said for the earth?

MR. FRASER - A huge quantity like this, in 1917, taking chances of running over three years, I am not sure how high my ideas had gone in 1917. I know that in 1919 I would have said $1.00.

In the fall of 1917 experienced contractors like A. C. Douglass, Hugh L. Cooper and Company, etc., told us that the earth could be taken out for prices ranging from 35¢ to 38¢ with steam operated equipment, and that rock could be taken out for prices ranging from $1.56 to $1.75 with steam operated equipment.

The attached curve, Appendix 13, shows the contract prices for earth and rock on the Calument-Sag section of the Chicago Drainage Canal in the fall of 1916, these curves being compiled from figures similar to those set forth in Mr. Goodwin's report on excavation methods and equipment.

In Appendix 14 attached are tabulated actual unit costs for earth and rock which obtained in the Niagara work during 1917, 1918 and 1919. It would appear from these figures that Mr. Fraser would have made quite a lot of money if he had had the contract at $2.00 for rock and $1.00 for earth. Conversely, it would appear to show that we exercised good judgment in deciding to do the work ourselves.

PAGE 5348:

> MR. HANEY - Up to the time of the strike they evidently must have worked with a force of approximately 2,000 men. Then they had a strike and they put on a night force and they increased their working force to 8,000 men and I presume they increased their plant. Then they dropped the night force and dropped back to 3,000 men. I cannot understand what they did with these 5,000 men, assuming they did work a night gang.

> MR. FRASER - They were running night shifts on the shovels.

Night shifts were being worked on the shovels for some time before the strike of 1920, and this fact had nothing to do with the increase in the working force, except insofar as it was necessary to add the working force required to

In the fall of 1917 experienced contractors like A. C. Douglass, Hugh L. Cooper and Company, etc., told us that the earth could be taken out for prices ranging from [illegible] to [illegible] with steam operated equipment, and that rock could be taken out for prices ranging from $1.50 to $1.75 with steam operated equipment.

The attached curve, Appendix 12, shows the contract prices for earth and rock on the Calumet-Sag section of the Chicago Drainage Canal in the fall of 1912, these curves being supplied from figures similar to those set forth in Mr. [illegible]'s report on excavation methods and equipment.

In Appendix [illegible] attached are tabulated actual unit costs for earth and rock which obtained at the Niagara work during 1917, 1918 and 1919. It would appear from these figures that the [illegible] would have made quite a lot of money if he had let the contract at $2.00 for rock and $1.00 for earth. Conversely, it would appear to show that we exercised good judgment in deciding to do the work ourselves.

COPY

[illegible]

> [illegible] - Up to the time of the strike they evidently must have worked with a force of approximately [illegible] men. Then they had a strike and they put on a night force and then increased their working force to [illegible] men and I presume they increased their plant. Then they dropped the night force and dropped back to [illegible] men. I cannot understand what they did with those 3,000 men, assuming they did work a night gang.

> [illegible] - They were running night shifts on the shovels.

Night shifts were being worked on the shovels for some time before the strike of [illegible], and this fact had nothing to do with the increase in the working force, except insofar as it was necessary to add the working force required to

operate the two new shovels and auxiliary equipment purchased in the fall of 1920. This, of course, accounted for a considerable number of extra men.

Without attempting to discuss the accuracy of the figures quoted in Mr. Haney's above statement, it may be stated that the main cause for the increase in the number of men was that up to the fall of 1920 no concrete work had been undertaken, and the construction of the power house had not been started. The construction work on the power house started in November of 1920 and the concrete work in the canal started in the early part of the year 1921. Also, the construction work on the gate-house started in the spring of 1921. These three new operations reached the peak of their activity about June of 1921, and then tapered off gradually until in July form construction and similar classes of work began to wind up, and a considerable number of carpenters and other classes of labor were laid off. Furthermore, in July of 1921, when arrangements were made with the Niagara Falls Power Company to carry the fall peak on the Niagara System until the end of the current year, the construction schedule was extended from September 1st to January 1st, thus enabling a considerable portion of the night shift work to be discontinued, and allowing a further considerable reduction in the working force.

The abolition of the night shift, and the redistribution and culling out of the working force thereby made possible, had an immediate and marked effect on operating efficiency, as indicated by the discussion in Appendix 15 attached.

PAGE 5348:

MR. HANEY - In order to do $30,000,000 worth of work they spent $17,000,000 on plant. What do you think of that?

MR. FRASER - That is a much larger amount than we ever spent; a much larger proportion.

This statement means nothing to Mr. Fraser, as the figures quoted are neither correct nor in accord with Mr. Fraser's understanding of the situation from a contractor's standpoint. This particular phase of the argument is covered by Appendix 8 previously referred to.

PAGE 5349:

MR. GREGORY - What have you to say about working at the peak first?

MR. FRASER - Looking at the diagram showing the percentage of earth and rock excavated each month throughout the progress of the work, I would say that the output in the early months was too small, considering the total work to be done in the time.

MR. GREGORY - How would you have gone about it?

MR. FRASER - We would have had to have much better progress the first year. Their first year of earth excavation was away short and the rock excavation started too late.

As previously stated, these opinions of Mr. Fraser as to the working schedule are worthless by reason of the wrong premises given him upon which to base his judgment, as it was never contemplated that the work described to Mr. Fraser would be completed in three years. The explanation of the apparent lack of progress in 1917 is fully covered in Appendices 5 and 6 of my report of December 28th, 1917, and if this program had been shown to Mr. Fraser he would not have expressed the opinions above quoted.

PAGE 5349:

MR. GREGORY - Do you mean the rock excavation started too late in order to do the work most economically?

MR. FRASER - Yes, from my very brief examination of the profiles, it looks as if an independent start could have been made on both sides of the high cut at about mileage 3.

This statement does not seem to agree with the opinion expressed by Mr. Fraser on pages 5329, and 5330 of the evidence, where he states that the proper procedure would be to remove the earth overburden first, and then attack the rock "from every point that you can get in".

PAGE 5349:

MR. HANEY - If they had adopted another progress program they would have had a much larger percentage of the work done before the prices went up?

MR. FRASER - Yes, but that was something that would have been hard to foresee.

Mr. Haney could have framed this question more fairly as follows:- "If the progress program set forth in the report of December 26th, 1917, had been followed, they would have had a much larger percentage of the work done before the prices went up". The answer to this question will be found in Appendix 16 attached, which indicates not only that the earth and rock work have been completed within the schedule time, without the extra plant purchased in 1920, but also that it would have been completed for a figure corresponding very closely to the 1917 estimate. It can only be repeated once more that the only progress program followed during the period between the spring of 1918 and the early fall of 1920 was the program forced upon us by the war, and the undreamed-of conditions, arising out of the war, subsequent to the armistice.

PAGE 5350:

MR. R. A. ROSS - What is your idea about costs after the war? We were looking forward when the war was over that prices would go down. Would you not expect them to come down quickly after the war?

MR. FRASER - Yes.

MR. [illegible] - And yet the peak did not occur until 1920 - two years after?

MR. FRASER - We anticipated a drop when the war ended.

The above statements are fully in accord with my evidence given before Mr. Rowell, pages 4145 to 4149, and 4181 to 4182, inclusive. As then stated, in connection with the status of the original estimates in January, 1919, it was thought that conditions as then existing, a year after the war, could not possibly become worse, and the break, which would mark a rapid return to conditions approximating those which existed before the war, was expected daily.

At this time not a yard of concrete had been placed, only 11.7% of the earth, and 3.6% of the rock had been removed, and the overrun on rock and earth costs was of such a trifling nature, when considered in relation to the amount of work still to be done, that no anxiety was felt as to making this overrun good when the expected break in industrial conditions materialized.

PAGE 5352:

MR. HANEY - The cost of unwatering that plant was put in at $1,800,000?

MR. FRASER - I have no idea what they did.

MR. HANEY - You would not have any idea as to what was necessary?

MR. FRASER - Not without making a study of the plant. I have never heard what unwatering they had to do. It is a most difficult item to figure.

The amount of this item is far beyond anything that was anticipated when the work was undertaken and must, of course, take its share of the burden

imposed by the unforeseen working conditions which existed up to the fall of 1920. This general condition resulted in a disruption of the pre-arranged working program which made it impossible to obtain the gravity drainage into Bowman's Gully which was originally contemplated, and which has been previously referred to in this memorandum. See also Appendix 11.

Apart altogether, however, from the general condition above mentioned, one specific factor having an immediate bearing on unwatering cost was the existence of innumerable living springs discharging into the cut through vertical fissures in the solid rock. As previously stated, a number of these big springs were actually uncovered by the excavation, and others undoubtedly existed elsewhere under the overburden, on both sides of the canal. Therefore, instead of having to dispose temporarily of ground water seepage, it was necessary to handle a large continuous inflow from these springs. This inflow, furthermore, had to be disposed of almost wholly by local pumping on account of being unable to obtain the anticipated free drainage into Bowman's Gully. During the period between the spring of 1920 and the fall of 1921, it was necessary to handle as much as 20,000,000 gallons per day by local pumping, with over 30,000,000 gallons of installed pump capacity. There is no rational means of determining by what amount the cost of unwatering would have been reduced if these big springs had not existed, as the total amount of water handled was a combination of spring inflow and ground water seepage, and it is impossible to estimate what proportion of the total inflow was respectively chargeable to these two sources of supply.

PAGE 5353:

MR. ROSS - Material costs were at their peak in May, 1920, and I

fancy labor cost would be a month or two later.

MR. FRASER - Some big jobs were discontinued in September. We had a big job cancelled in September, 1920, and costs were just tumbling from that time, and anybody making an estimate on the 1920 costs in 1920 would be sure to over-estimate.

Practically all capital obligations on the Niagara work were incurred previous to 1920, and the benefit of the reduced labor costs did not obtain on this work until August, 1921.

PAGE 5853:

MR. GREGORY - How would these prices Mr. Francis has given you compare with estimates for similar work you were making at the time, at the end of 1917?

MR. FRASER - They are lower than ours.

The above statements apply to concrete prices quoted by Mr. Francis and applicable to the work as estimated in 1917. In this connection, please note Appendix 13 of my report of December 26th, 1917, in which the price of concrete is estimated in the fall of 1917 by some fairly prominent engineers and contractors. For instance, one contractor, P. McGovern & Company, estimates $6.50 per yard as a tender price, which would, of course, include an estimated profit. This price should therefore be compared with the average estimated price for canal concrete in the estimate of December 26th, 1917, which was $8.80, plus 25%, or $11.00 per yard. It may be well to note also that the $10.00 and $12.00 prices quoted by Mr. Francis for reinforced concrete are really mass concrete prices, as the steel was in all cases estimated separately, and applied to temperature bars exclusively. The $6.50 price applied wholly to bottom concrete placed without any form construction whatever.

[illegible] labor cost would be a month or two later.

MR. [illegible] - [illegible] in [illegible], [illegible] [illegible] in [illegible], 1930, and [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] costs in 1930 would be [illegible].

Practically all [illegible] [illegible] [illegible] on the [illegible] were [illegible] previous to 1930, and the benefit of the reduced [illegible] [illegible] at this time [illegible] August, 1931.

[illegible]:

MR. [illegible] - [illegible] would [illegible] prices Mr. Francis has given you compare with [illegible] at the time, if [illegible]

MR. [illegible] - They are lower than ours.

The above statements apply to concrete prices quoted by Mr. Francis and applicable to the work as estimated in 1927. In this connection, please note Appendix 12 of my report of December [illegible], 1927, in which the price of [illegible] is estimated in the fall of 1927 by [illegible] contractors and [illegible]. For instance, the contractors, [illegible], estimated $[illegible] per yard as a [illegible] price, which would, of course, include an estimated profit. This price should therefore be compared with the [illegible] estimated price for [illegible] in the estimate of December [illegible], 1927, which was $[illegible], plus 25%, or $11.00 per yard. It may be well to note also that the $10.00 and $11.00 prices quoted by Mr. Francis for [illegible] concrete are really mass concrete prices, as the steel was in all cases estimated [illegible] and applied to [illegible] [illegible] exclusively. The $[illegible] price is [illegible] to [illegible] concrete placed without any form reinforcement whatever.

PAGE 5354:

MR. GREGORY - As a matter of fact, the actual cost (of concrete) ran up to $21.00 and $30.00. How do you account for a simple block of ordinary concrete costing $24.00?

MR. FRASER - I could not say.

Obviously, Mr. Fraser could not make any other answer, as he had never seen the work, and therefore could not know just what Mr. Gregory meant by "a simple block of ordinary concrete". As a matter of fact, not a yard of this concrete was placed in the power-house substructure, the gatehouse substructure, or in the canal lining walls until the fall of 1920, and after the work had been checked up and re-estimated by independent engineers in the light of known conditions obtaining since 1917. The average price of $24.00 mentioned by Mr. Gregory has, therefore, no direct connection with the prices in the 1917 estimate, but is comparable on the other hand, with the prices estimated by Stuart and Kerbaugh and H. L. Cooper and Company in 1920. The average price of concrete as estimated by Stuart and Kerbaugh was $16.80 per yard, and the average price of concrete as estimated by H. L. Cooper and Company was $18.46 per yard.

PAGE 5368:

MR. HANEY - Do you think they had sufficient knowledge of the character of the work to realize that?

MR. CHADWICK - Oh, they should know that a contractor could not prepare an intelligent bid for work of that magnitude in that time.

We also know that no contractor would do so. This opinion is confirmed by Mr. Chadwick's answer to the next question as put to him by Mr. R. A. Ross.

PAGE 5371:

MR. HANEY - Would you use such a type of shovel as was used there?

MR. CHADWICK - I could not say as to that because I never went into it far enough to find out what our plant would be, but I think we would use the standard shovel. I do not think a contractor would, or could, load up with that kind of equipment.

We knew this at the time the decision was made to do the work on force account, and we also knew that the work could not be done with standard shovels.

PAGE 5374:

MR. GREGORY - We have no record of any contractor who ever considered giving a lump sum contract. I was asking you about terms upon which you would be prepared to take it.

MR. CHADWICK - I do not think any contractor could possibly have taken that on a lump sum contract.

We were fully aware of this attitude on the part of contractors at the time the decision was made to do the work on force account.

PAGES 5374 and 5375:

In these two pages of the evidence Mr. Chadwick expatiates on the advantages of a coherent and expert working organization. As previously set forth in connection with Mr. Larkin's evidence, a precisely similar organization handled the Niagara work. This work was in charge of two of the best construction men in America, and the important positions in the organization were filled by men who had worked with them, and with each other.

for years.

Mr. Chadwick's statement that a considerable number of his foremen were employed on this work is evidence of the fact that the Foundation Company does just as any other construction organization would do; namely, when a new piece of work is undertaken, they go into the market for their foremen and hire them for that particular job. If the Foundation Company had been given the Niagara work on a cost-plus basis, they would have had to go into the market for 90% of their supervisory force, and if they had any other work in progress, at the time of getting the Niagara work, what they would have done would have been to assign one or two men only to this work from their permanent organization, and a supervisory force would have been organized on an entirely new basis from that point down. They would, of course, endeavor to re-employ as many of their old men as possible, but as previously stated, this is precisely what was done under the conditions which actually obtained.

PAGE 5380:

MR. GREGORY - Was there any comprehensive plan of the whole work submitted to you?

MR. CHADWICK - No.

There was no such plan in existence at that time. This phase of the situation is fully covered in FR, Chapter G, pages 3, 15, 31, 32, 33 and 34.

PAGE 5384:

MR. GREGORY - What would you say to the qualification of this man Salter as a purchasing agent? Would he be fully qualified to do the purchasing for construction work?

our part.

Mr. Thatcher's statement that a considerable number of his foremen were employed on this work is evidence of the fact that the Foundation Company does just as any other construction organization would do; namely, when a new piece of work is undertaken, they go into the market for their foremen and hire them for that particular job. If the Foundation Company had been given the Niagara work on a cost-plus basis, they would have had to go into the market for [illegible] of their supervisory force, and if they had any other work in progress, at the time of getting the Niagara work, what they would have done would have been to assign one or two men only to this work from their permanent organization, and a supervisory force would have been assembled [illegible] from that point down. They would, of course, endeavor to re-employ as many of their old men as possible, but as previously stated, this is precisely what was done under the conditions which actually obtained.

[illegible]

MR. [illegible] - Was there any comprehensive plan of the whole work submitted to you?

MR. THATCHER - No.

There was no such plan in existence at that time. This phase of the situation is fully covered in Vol. Chapter [illegible], pages [illegible] and 24.

[illegible]

MR. [illegible] - What would you say to the qualification of this man [illegible] as a purchasing agent? Would he be fully qualified to do the purchasing for construction work?

MR. CHADWICK - I would probably say no, that he would be very well qualified as a purchasing agent for the Hydro-Electric Power Commission but not as a purchasing agent for a construction contract.

Mr. Chadwick is correct, and the purchases referred to were not made by Mr. Salter.

PAGE 5385:

MR. HANEY - We are dealing with contractors' requirements for construction purposes, which is very different from the regular purchases of an organization.

MR. CHADWICK - Yes, he has got to know the stuff he is buying. As a rule in our organization, the same man that purchases material for the work does not purchase plant. The General Superintendent himself purchases the plant.

The procedure on the Niagara work was precisely similar to that outlined above by Mr. Chadwick. Materials, such as cement, rail, ties, poles, copper wire, etc., were purchased through Mr. Salter's department. Plant, such as drills, shovels, compressors, conveyors, rock crushers, locomotives, etc. were purchased through the Plant Engineer on the work, who was under the immediate jurisdiction of the General Superintendent. In this latter case the function of the Purchasing Department was limited to the official confirmation of the order, and the issue of the necessary formal documents.

PAGE 5386:

MR. R. A. ROSS - Acres would make up his mind that he wanted a certain class of equipment to carry out a certain program, and then he would turn that over with full specifications to the Purchasing Agent and say - "Here, get this for me".

MR. CHADWICK - I would probably say no, that he would be very well qualified as a purchasing agent for the Hydro-Electric Power Commission but not as a purchasing agent for a construction contract.

Mr. Chadwick is correct, and the purchases referred to were all made by Mr. Salter.

PAGE 2383:

MR. HARDY - We are dealing with contractors' requirements for construction purposes, which is very different from the regular purchases of an organization.

MR. CHADWICK - Yes, he has got to know the stuff he is buying. As a rule in contracting the same man that purchases material for construction does not purchase plant. The General Superintendent himself purchases the plant.

The procedure on the Niagara work was precisely similar to that outlined above by Mr. Chadwick. Materials, such as cement, rails, ties, poles, copper wire, etc., were purchased through Mr. Salter's Department. Plant, such as drills, shovels, compressors, derricks, rock crushers, locomotives, etc. were purchased through the Plant Engineer on the work, who was under the immediate jurisdiction of the General Superintendent. In this latter case the function of the Purchasing Department was limited to the official confirmation of the order, and the issue of the necessary formal documents.

PAGE 2384:

MR. W. A. ROSS - Jones would make up his mind that he wanted a certain class of equipment to carry out a certain purpose, and then he would turn that over with full specifications to the Purchasing Agent and say - "Here, get this for me".

He did more than that. He issued the specifications, where such were necessary or possible, received the quotations or tenders, got the General Superintendent's opinion as to the proper quotation or tender to accept, and finally closed the deal, subject only to the final authorization of the Commission and the Chief Engineer for the expenditure. The completed negotiation was then turned over to the Purchasing Department for the routine procedure. This routine procedure involved no delay or misunderstanding whatever, as all essential negotiations with the vendor had previously been completed.

PAGE 5389:

MR. HARRIS- They had a great chance in the early part of 1919 to make their purchases and secure everything they required, because for six months everything was in a very uncertain condition. If they had come into the market then they could have made better contracts.

MR. CHADWICK - Yes, if they could have foreseen. We can look back and say Yes, but at the time we might not have foreseen what was to occur.

From the practical standpoint alone, the impracticability of Mr. Harris' idea is evident, because even if contracts for material and plant needed for future use could have been placed in the early part of 1919, the handling, storage, and carrying costs would have been such that no one would have considered any such method of procedure.

Furthermore, the condition was just as Mr. Chadwick mentions above. No buying was done at that time beyond current requirements because everybody was waiting for the big break which was expected to occur any day at that time. Also, as a matter of fact, Mr. Harris' statement is wrong in respect of the particular commodities which were needed on the Niagara work, as Appendix 17

It did more than that. It issued the specifications, where [illegible] necessary or possible, received the quotations or tenders, got the General Superintendent's opinion as to the proper material or tender to accept, and finally closed the deal, subject only to the final authorization of the Commission and the Chief Engineer for the expenditure. The completed requisition was then turned over to the Purchasing Department for the routine procedure. This routine procedure involved no delay or misunderstanding whatever, as all essential negotiations with the vendor had previously been completed.

[illegible]:

> Mr. HARRIS - They had [illegible] in the early part of 1918 to make their purchases and secure everything they required, because for six months everything was in a very uncertain condition. If they had gone into the market then they would have made better purchases.
>
> Mr. [illegible] - Yes, if they could have foreseen. We had [illegible] and any day, but at the time we might not have foreseen what was to occur.

From the practical standpoint alone, the impracticability of Mr. Harris' idea is evident, because even if contracts for material and plant needed for future use could have been placed in the early part of 1918, the handling, storage, and carrying costs would have been such that no one would have considered any such method of procedure.

Furthermore, the condition was just as Mr. [illegible] mentions above. No buying was done at that time beyond current requirements because everybody was waiting for the big boom which was expected to occur any day at that time. Also, as a matter of fact, Mr. Harris' statement is wrong in respect of the particular commodities which were needed on the Chippawa work, as Appendix 12

attached hereto will indicate. The price curves on this sheet are authentic, and show no drop whatever in the early part of 1919. Mr. Harris' statement may have applied to the speculative commodities, such as sugar, wheat, cotton, etc., but it did not apply generally in connection with the plant and standard commodities used on engineering construction work.

PAGE 5390:

MR. HANEY - Comparing the railways with Hydro, would the railways be in a better position to do the work themselves than Hydro at the time this work was done?

MR. CHADWICK - I would say the railways would be in a little better position to do their own work.

If the railways had been up against the same proposition as the Hydro during the war, with regard to a large piece of work, they would not have done it at all, and certainly not in the public interest, or for the purpose of furnishing needed assistance to the allied armies. Leaving out conditions which obtained during the war, with regard to the absolute urgency of providing electric power for the manufacture of munitions and other war materials, the Hydro has never handled a large power development work in any other way than by schedule contract. This was the practice before the war, and it is the practice at the present time.

PAGE 5391:

MR. HANEY - Do you know what it is costing on an average to do that kind of work?

MR. CHADWICK - Oh, yes, it was costing us all kinds of prices for different classes of work. For instance, we were taking out earth at Port Colborne during the war and we were hauling over a mile and making a fill with it for 26¢ per yard, as far as I can remember.

attached hereto will indicate. The [illegible] in this [illegible],
and even so [illegible] in the early part of 1918. Mr. [illegible] statement
may have applied to the speculative commodities, such as [illegible],
etc., but it did not apply generally in connection with the plant and machin-
ery commodities used in engineering construction work.

[illegible]:

MR. TILLEY - Comparing the railways with Hydro, would the railways be in a better position to do the work themselves than Hydro at the time this work was done?

MR. [illegible] - I would say the railways would be in a little better position [illegible].

COPY

If the railways had been to conduct the same preparation as the Hydro during the war, with regard to a large piece of work, they would not have done it at all, and certainly not in the public interest, or for the purpose of furnishing needed assistance to the allied cause. Leaving out conditions which obtained during the war, with regard to the absolute urgency of providing electric power for the manufacture of munitions and other war materials, the Hydro has never handled a large power development work in any other way than by [illegible]. This was the practice before the war, and it is the practice at the present time.

[illegible]:

MR. TILLEY - So you know what it is costing as an average to do that kind of work?

MR. [illegible] - [illegible] different classes of work. For instance, [illegible] a mile and making a [illegible] as far as I can remember.

This statement does not square very well with Mr. Fraser's opinion that the cost of earth should have been $1.00 per yard at Niagara in 1919, and furthermore demonstrates the utter absurdity of comparing the unit costs of earth and rock work on different jobs, without complete and authentic data as to the comparative local and general conditions. Neither Mr. Fraser nor Mr. Chadwick ever saw the Niagara work at any time.

PAGE 5392:

MR. FRANCIS - The estimates were from $6.50 to $12.00 per yard. $6.50 was for plain concrete and $12.00 for reinforced.

In this connection please note the discussion of Mr. Fraser's evidence under this head on pages 5353 and 5354.

As previously stated, in connection with Mr. Fraser's evidence on concrete cost, the $12.00 price was really a mass concrete price, owing to the fact that the steel was simply temperature reinforcement, and was all figured separately. Reference to FR, chapter K, Appendix 6-I, will show that out of a total estimated quantity of 353,473 cubic yards of mass concrete, only 59,813 yards of formless bottom concrete, or 17%, was estimated as low as $6.50 per yard, and the balance of 83% was all estimated at $8.00, $10.00 and $12.00, plus a contingency item of 25%.

PAGE 5393:

MR. GREGORY - Do men work as well for a Government commission as for a contractor?

MR. CHADWICK - No, I do not think they do.

This statement does not square very well with Mr. Fraser's opinion that the cost of earth should have been $1.25 per yard at Niagara in 1924; and furthermore demonstrates the utter absurdity of comparing the unit costs of earth and rock work on different jobs, without complete and authentic data as to the respective local and general conditions. Neither Mr. Fraser nor Mr. [illegible] ever saw the Niagara work at any time.

CONCRETE:

Mr. [illegible] - The estimates were from $6.50 to $12.00 per yard. $6.50 was for plain concrete and $12.00 for reinforced.

COPY

On this statement please see my analysis of Mr. Fraser's evidence under this head on pages 123 and 124.

As previously stated, in connection with Mr. Fraser's evidence on concrete costs, the $12.00 price was really a mass concrete price, owing to the fact that the steel was simply temperature reinforcement, and was all figured separately. Reference to H. Chapter I, Appendix H-1, will show that out of a total estimated quantity of 525,425 cubic yards of mass concrete, only 15,210 yards of cyclopean concrete, or 3%, was estimated as low as $6.50 per yard, and the balance of 97% was all estimated at $9.00, $10.00 and $12.00, plus a contingency item of 25%.

[illegible]:

Mr. [illegible] - Do you think it would pay a Government commission as for a contractor?

Mr. [illegible] - No, I do not think they do.

In this connection it might be interesting to ascertain how the contractors on the Welland Ship Canal found conditions during the war, and how they are finding them at the present time. The position of a contractor on the Niagara work would not be in any degree different from the situation of the contractors on the Ship Canal, and his working force would not show any more efficiency, energy and co-operative spirit than the working forces of the Welland Ship Canal contractors. At the present time, we appear to be getting better results out of our "government" labor than the privately controlled labor of the B. E. Steel Corporation, for instance.

PAGE 5296:

MR. CHADWICK - The impression there was that the work was extravagantly carried on as far as plant was concerned. They could have almost anything in the way of plant or equipment they chose to ask for. That is what my own men told me.

About the only thing we could get when we wanted it was plant and equipment, and even that was often months later than the definite promise of delivery, and was a mixture of bad material and bad workmanship when it finally arrived. Mr. Chadwick's men were on the job during the period of the rush schedule, when the work was admittedly over-planted, and for a good and sufficient reason, which was to make good the lost 12 months of working schedule which obtained during the previous period of operations, but even so the percentage of contractors' plant investment was only 12 to 15%.

PAGE 5397:

MR. HANEY - What is your practice in rushing your work? Do you rush it at the beginning or at the end?

MR. CHADWICK - We try to schedule our jobs all through. As soon as anything runs a day behind schedule we get after it so that there is never any rush operation on the work.

As previously stated, any sensible construction man would do the same thing, and the only schedule under which it was ever possible to operate, namely, the schedule drawn up in the early fall of 1920, was checked and adhered to just as Mr. Chadwick states.

COPY

PAGE 5398:

MR. HANEY - Or would you think it better to wait until near the end of the work and then buy a tremendous amount of plant to finish it up in a hurry?

MR. CHADWICK - No, we buy our plant at the start. If we have to buy any plant during the progress of the work it is due to the fact that somebody has made a mistake.

In asking this question Mr. Haney has made a misstatement of facts. At the time the plant he mentions was bought, not a yard of concrete had been placed in the power house, gatehouse, canal or intake; only 22% of the rock had been excavated from the canal; and only 50% of the overburden had been removed. It is manifestly incorrect, therefore, to say that this "tremendous amount of plant" was bought "near the end of the work".

Without casting any reflection whatever upon Mr. Chadwick, it may be fair to state that no piece of work he has ever scheduled or planted has required anything more than two or three railroad type shovels, and a few derricks, concrete mixers and dinkeys, with the usual complement of small

tools, such as drills, track jacks, pinch bars, picks and shovels, etc. The first Cedars job, with 8 railroad shovels as the main item of plant, appears to have been the largest piece of work yet handled by the Fraser-Brace Company.

(Signed) H. G. Acres

HYDRAULIC ENGINEER.

30th April, 1920.

Dear Mr. Drury:-

I have noticed an article in the "Financial Post" of Toronto in the issue of 17th April entitled "Government following sane course in regard to Hydro". The tenor of the article is in the nature of criticism of the ability of the engineering staff of the Hydro-Electric Power Commission in connection with the power work throughout the province and particularly refers to what is known as the Chippawa Scheme.

While I do not desire to discuss the matter in the press by meeting the criticism as it should be met, I feel it almost a duty to draw it to your attention and to tell you that I think the implied criticism unjust to the senior members of the engineering staff of the Commission, especially as practically all of those concerned are graduates of the Faculty of Applied Science in the University, of which I have the honor to be Dean.

Not only is it not fair to imply that these senior members - those who are in a large measure responsible for the design and execution of the various hydro electric power works - are young and inexperienced. It must be recognized by anyone desiring to criticize on this score that Hydro Electric Power Engineering is completely new; I myself saw its inception and was engaged in the first work of this kind commencing at Niagara Falls in 1892, though it was not until the years 1901-1905 that the large Niagara works were constructed on the Canadian side.

Practically all of the senior members of the Commission's present staff

were engaged on the Niagara Power works during these periods and obtained their experience in the design, construction and operation of hydro electric plants in these and later projects both in Canada and the United States. Mr. Gaby, the Chief Engineer, a graduate of Toronto in Electrical Engineering in 1903 was engaged for some time in those early years with the Electrical Development Co., both at Niagara Falls and Toronto and has had a very large electrical experience since. Mr. Acres and Mr. Sauer, the mechanical engineers, both graduates of Toronto in Mechanical Engineering in 1903 and 1901 respectively, obtained their first experience at Niagara Falls on the power works in those years and have been engaged in similar work ever since. Mr. Goodwin, in charge of construction of the Chippawa Scheme, is a graduate of Toronto in Civil Engineering in 1892 (my own year), has been engaged in Niagara Falls Power and similar works on the outside construction side practically ever since graduation and is acknowledged to have wide experience and ability in actual construction methods. Mr. Brandon, the Electrical Engineer, of the Commission, is a graduate of Toronto in Electrical Engineering in 1901 and has since seen continuous service in large power engineering on the electrical side in the Niagara Falls power works and elsewhere. So with Mr. Hogg, the Hydraulic Engineer, who is a graduate of Toronto in Civil Engineering in 1907, although he along with nearly all of the foregoing was engaged before that time with me on the original construction of the Ontario Power Company's development during the years 1901-1906.

COPY

I hope you will pardon this lengthy letter in this matter but as I said before I felt it my duty as so concerned with the education and success of our Canadian Engineers who are graduates of the Provincial University, to draw these

facts to your attention so that you may be better assured that the engineering of these great provincial power undertakings is in good hands.

Yours faithfully,

(SGD.) C. H. MITCHELL,

Dean.

The Hon. E. C. Drury,
Premier of Ontario,
Parliament Buildings,
TORONTO, Ont.

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APPENDIX 2.

PERFORMANCE OF RAILROAD TYPE SHOVELS UNDER WORKING CONDITIONS

This appendix includes extracts from the engineer's daily reports and notations of statements made by the runners who were operating these shovels at the times to which references are made. These notes cover conditions obtaining on the whole territory between Portage Road and Bowman's Gully.

SHOVEL NO. 3:

In the second cut - station 275 to 271.

This shovel worked during February and March, 1919, day shift. The cut was abandoned on March 18th and the shovel moved to the forebay. The material ahead of the cut was removed during the following months by dragline.

Extracts from daily reports, March 1st to March 18th:

DATE	C.Y.REMOVED (CAR YARDAGE)	REMARKS RE DELAYS
Mar. 1	944	3/4 hr. car off track; 3/4 hr. waiting for cars
" 3	1,136	
" 4	448	2 hrs. car off track; 1 hr. delay in water; 1/2 hr. repairing block
" 5	-	No work
" 6	560	1 hr. waiting for cars; 1 hr. car off track.
" 7	288	6 hrs. moving and pumping.
" 8	592	
" 10	368	7 hrs. waiting for stone.
" 11	320	
" 12	464	

COPY

Appendix 2 ..... 2.

DATE		C.Y.REMOVED (CAR YARDAGE)	REMARKS RE DELAYS
Mar.	13	352	5 hrs. moving
"	14	480	
"	15	592	
"	17	240	
"	18	-	Dismantling

Note: No remarks are given for days where delays are not indicated. Difficulty in this material, however, is clearly shown by comparison of yardages for those days where delays are explained.

SHOVEL NO. 5: (Caterpillar Traction, Type 18-B)

In top cut - station 275 to 282. Day shift October and November, 1918.

This shovel was structurally adapted to soft ground digging and was working in cut from two to seven feet face.

Extracts from daily reports:

DATE		C.Y.REMOVED (CAR YARDAGE)	REMARKS RE DELAYS
Oct.	28	58	8 hrs. repairs; 1 hr. moving back.
"	29	-	10 hrs. repairing.
"	30	-	8 hrs. repairing hoisting engine; 2 hrs. moving in quicksand.
"	31	-	10 hrs. jacking out of quicksand.
Nov.	1	180	
"	2	260	4 hrs. waiting wagons
"	4	-	10 hrs. putting in new piston
"	5	230	5 hrs. stuck in quicksand
"	6	-	10 hrs. blocking out of quicksand
"	7	-	10 " " " " "
"	8	275	2 hrs. waiting on wagons; 3½ hrs. getting out of quicksand
"	9	240	3½ hrs. waiting on wagons; 2½ hrs. shut down on account of rain.

SHOVEL NO. 3:

In first cut - station 290 to 310. This shovel went in on October 19th,

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Appendix 2 ..... 3.

1918 on day shift.

Extracts from daily reports, week of October 19th to October 25th:

DATE	C.Y.REMOVED (CAR YARDAGE)	REMARKS RE DELAYS
Oct. 19	160	
" 21	324	
" 22	-	10 hrs. putting shovel on track
" 23	368	8 hrs. putting rock under shovel
" 24	1,040	6 hrs. putting stone under shovel
" 25	96	7 hrs. shovel off track; 2½ hrs. waiting for crushed stone
" 26	240	Delayed, soft bottom.

Information furnished by shovel operator:

On the evening of the 25th, the shovel was in such danger of being lost that two locomotives were called out at quitting time and it required the combined efforts of these locomotives together with the shovel traction helped by pushing with dipper arm, to restore shovel to a position of safety. During a portion of this period it required about 32 cars of crushed stone to enable the shovel to dig its own length.

SHOVEL NO. 7:

In cut station 324 to 332. This shovel worked during summer and fall of 1917 in cut just south of Bowman's Gully on day shift.

Extracts from daily reports:

DATE	C.Y.REMOVED (CAR YARDAGE)	REMARKS RE DELAYS
Oct. 8	800	5 hrs. moving in quicksand
" 9	112	7 hrs. quicksand; 2 hrs. moving back
" 10	300	5 hrs. moving

Appendix 2 ..... 4.

DATE	C.Y. REMOVED (CAR YARDAGE)	REMARKS RE DELAYS
Oct. 11	1,008	
" 12	-	Rain
" 13	1,200	30 minutes, shovel off track
" 15	640	2 hrs. cable repairs; 2 hrs. quicksand
" 16	400	7 " lost account of quicksand
" 17	432	7 " " " " "
" 18	448	4 " quicksand; 3 hrs. repairs
" 19	-	Rain
" 20	672	8 hrs. 40 minutes quicksand
" 22	576	6 hrs. 15 minutes quicksand
" 23	-	Rain
" 24	-	"
" 25	-	"
" 26	528	3 hrs. quicksand; 3 hrs. break-down
" 27	288	3 hrs. " 5 hrs. moving
" 29	-	5 hrs. throwing track; 5 hrs. rain
" 30	192	8 hrs. bad track
" 31	400	7 " "
Nov. 1	496	6 " 30 minutes, bad track
" 2	416	7 " bad track

Information furnished by shovel operator:

During a portion of this time the shovel was carried on a grillage of four layers of trees laid flat on which was placed two or three layers of ties. The loading track itself was blocked up on successive layers of ties as the original track disappeared in the quicksand.

Note: The work during 1917, 1918 and 1919 was confined principally to the district north of Lundy's Lane.

The experience gained during this early period of the work was made use of in reference to the extension of digging operations in earth to the south after that time. Consequently, there is only occasional reference in later reports to trouble due to soft bottom in connection with the use of railroad type shovels, by reason of the fact that whenever such conditions were

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encountered, the program for these shovels was immediately altered, and the equipment was raised up to shallow cutting or removed to localities where conditions were less severe.

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A P P E N D I X 3.

TRESTLE CONSTRUCTION

Arrangements were made for the first trestle, which was at the main disposal, on March 1st, 1919.

The first construction and expenditures were made in March, 1919, and the last in September, 1921.

These trestles were built as conditions developed and as they were needed.

There were six trestles averaging 2,200 feet long each at the main disposal and eight trestles with average length of 2,100 feet at the Lundy's Lane disposal.

APPENDIX 3.

"What was Total FBM in Trestles, Total Cost,
Cost per MFBM, and Cost of Trestles,
per Cubic Yard of Disposal?"

MAIN DISPOSAL - 6 TRESTLES

TIMBER AND PILING	TOTAL COST	COST PER UNIT	TOTAL C.Y.DUMP EQUIV. BANK MEASUREMENT	COST OF TRESTLE PER C.Y.OF DUMP
816,281 MFBM	135,402.78	166.00	-	-
126,723 l. ft. rd.	64,648.47	.512	-	-
	200,051.25		6,114,162	3.25¢
For entire capacity at existing levels for same trestles			16,114,162	1.25¢

LUNDY'S LANE DISPOSAL - 8 TRESTLES

1,749,184 MFBM	221,951.00	127.00	-	-
7,538 l.ft. rd.	7,584.17	1.00	-	-
	229,535.17		3,795,204	6.05¢
For entire capacity for same trestles			5,435,204	4.2¢

Total length for all trestles, main disposal .... 13,200 ft.

Average height .... 47 "

Total length for all trestles, Montrose dump .... 16,800 ft.

Average height .... 35 "

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Appendix 5 ..... 2.

There were four stringers for tracks, each 12" x 14" x 40' and lapped every third bent - bents 13' centres.

All stringers were salvaged, in addition to complete bents that were not used.

The dumps so created by these trestles are capable of taking 10,000,000 more cubic yards at the main disposal and 1,640,000 cubic yards at Lundy's Lane without any additional expense for trestles.

The Lundy's Lane disposal was made necessary on account of congestion on the main line track due to concentration of excavating equipment opposite that disposal, and on account of tracks being at the same time heavily taxed for concrete requirements for lining, all of which resulted from delays in delivery of shovel equipment and abnormal conditions of wet excavation.

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APPENDIX 4.

RE PROPOSAL THAT THE HYDRO-ELECTRIC POWER COMMISSION SHOULD HAVE USED THE RAILROAD TYPE STEAM SHOVELS, SERVED BY FLAT CARS WITH HINGED SIDE DOORS - 25 CARS PER TRAIN, USING STEAM LOCOMOTIVES UNDER THE CONDITIONS OF A CONTROLLING GRADE 1/2 of 1%, AND UNLOADING AT THE DUMPS WITH PLOWS.

SHOVELS:

For purposes of discussion, it will be assumed that a 78-C Bucyrus shovel fills the specifications for shovel equipment. Ten of these shovels, having an average capacity of 2,000 cubic yards of earth per ten hours, would about equal the estimated capacity of the original equipment actually provided for this work.

CARS:

The cars are assumed to be flat cars with hinged side doors, and since it had been suggested that the Hydro-Electric Power Commission should have used the maximum size of standard car available, it is taken to mean that the size proposed should have about 30 cubic yards capacity. A car of this capacity, however, will have to have a floor space of 34' x 9' in order to take a load of 30 cubic yards of dry material, with slopes of 1½:1, and will weigh very close to 30,000 lbs.

It will therefore be assumed that the capacity is 30 cubic yards and the weight will be taken as 30,000 lbs. for each car. (A standard flat, without side doors, 36'10" long on the floor weighs 24,800 lbs.)

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COPY FOR [illegible] Mr. J. Allan [illegible]

APPENDIX A.

RE PROPOSAL THAT THE HYDRO-ELECTRIC POWER COMMISSION SHOULD HAVE USED THE RAILWAY TYPE [illegible] EQUIPMENT, STANDARD FLAT CARS WITH HINGED SIDE DOORS [illegible] RAIL, USING STEAM LOCOMOTIVES UNDER THE CONDITIONS OF A [illegible] GRADE 1/2 OF 1%, AND THE LOADING AT THE DUMPS WITH [illegible].

SHOVELS

For purposes of discussion, it will be assumed that a 70-C Bucyrus shovel fills the specifications for shovel equipment. One of these shovels, having an average capacity of 1,500 cubic yards of earth per ten hours, would about equal the estimated output of the original equipment actually provided for this work.

CARS

The cars are assumed to be flat cars with hinged side doors, and since it has been suggested that the Hydro-Electric Power Commission should have used the maximum size of standard car available, it is taken to mean that the size proposed should have about 20 cubic yards capacity. A car of this capacity, however, will have to have a floor space of 24' x 9' in order to take a load of 20 cubic yards of dry material, with slopes of 1½:1, and will weigh very close to 30,000 lbs.

It will therefore be assumed that the capacity is 20 cubic yards and the weight will be taken as 30,000 lbs. for each car. (A standard flat, without side doors, 40'10" long on the floor weighs 24,000 lbs.)

Appendix 4 ..... 2.

The length overall for the proposed car will be about 39 ft. and a train of 25 cars including engine, will be over 1,000 ft. long. This length of car will be hard to keep on the track when curves may reach 30° as is often necessary for construction purposes.

For ten shovels there should be two trains per shovel, and with the spares, a total of approximately 600 cars necessary, as the number of cripples is excessive where unloaders and plows are used, even where the material is dry and free-flowing, like gravel.

PLOWS AND UNLOADERS:

At the disposal ground there should be two plows and one unloader for each shovel, in order to avoid delays of waiting for this sort of equipment.

The two plows will be one right hand and one left hand, or, say, 22 plows in all for 10 shovels and 11 unloaders.

The above represents the equipment directly connected with excavation and does not include any provision for auxiliary needs, as hoists, wrecking cranes, other locomotives and cars, snow-plows, pumps, etc.

TWO CONTROLLING CONDITIONS - (A) and (B):

(A) - It may be fairly conceded that the choice of location for the main disposal area was the most logical and suitable, especially in consideration of the requirements that such a ground should have to meet. A disposal area for this work, that will satisfactorily fill all requirements, should have the following principal characteristics:

Appendix 4 ..... E.

The length overall for the proposed car will be about 39 ft. and a train of 12 cars including engine, will be over 1,000 ft. long. This length of car will be hard to keep on the track when curves may reach 10° as is often necessary for construction purposes.

For ten shovels there should be two trains per shovel, and with the spares, a total of approximately 480 cars necessary, as the number of cripples in excavation where unloaders and plows are used, even where the material is dry and free-flowing, like gravel.

PLOWS AND UNLOADERS:

At the disposal grounds there should be two plows and one unloader for each shovel, in order to avoid delays of waiting for this sort of equipment.

The two plows will be one right hand and one left hand, or, say, 22 plows in all for 11 shovels and 11 unloaders.

The above represents the equipment directly connected with excavation and does not include any provision for auxiliary needs, as hoists, wrecking cranes, other locomotives and cars, snow-plows, pumps, etc.

[illegible] - (A) and (B):

(A) - It may be fairly suggested that the choice of location for the main disposal area was the most logical and suitable, especially in consideration of the requirements that such a ground should have to meet. A disposal area for this work, that will satisfactorily fill all requirements, should have the following principal characteristics:

Appendix 4 ..... 5.

1 - Convenience to the centre of gravity of the excavation.

2 - Suitable depth to provide for the maximum practical spoil per unit of area, avoiding frequent track shifting, etc.

3 - Sufficient area to provide for the disposition of approximately 17,000,000 cubic yards of excavated material.

4 - Accessibility.

5 - Minimum first cost and minimum prospective damages to adjoining properties.

The area as selected is less than <u>two miles</u> from the main line of the construction railway (parallel to the canal) and about <u>four miles</u> from the centre of gravity of the total excavation.

COPY

It has an average depth of 65 ft. over an area of 200 acres thus providing ample space for at least 18,000,000 cubic yards of excavation.

It is accessible from the main line of the construction railway without crossing any of the existing steam or electric railways, and its location provides for a safe operating gradient for the disposal railway leading to it.

The land on which the disposal is located was for the greater part undeveloped and contiguous to similar properties.

Drainage is excellent and no claims for damages have been made to date.

(B) - It will also be seen that with 150 to 200 train movements per day across the Grand Trunk, Michigan Central, Wabash, and Niagara, St. Catharines and Toronto Railways, <u>grade crossings with these roads were out of the question.</u>

Appendix A ..... b.

1 - Convenience to the centre of gravity of the excavation.

2 - Suitable depth to provide for the maximum practical spill per unit of area, avoiding frequent track shifting, etc.

3 - Sufficient area to provide for the disposition of approximately 17,000,000 cubic yards of excavated material.

4 - Accessibility.

5 - Minimum first cost and minimum prospective damages to adjoining properties.

The area as selected is less than two miles from the main line of the construction railway (ground in the canal) and about four miles from the centre of gravity of the total excavation.

COPY

It has an average depth of [illegible] ft. over an area of [illegible] acres thus providing ample space for at least [illegible] cubic yards of excavation.

It is accessible from the main line of the construction railway without crossing any of the existing steam or electric railways, and its location provides for a safe operating gradient for the disposal railway leading to it.

The land on which the disposal is located was for the greater part undeveloped and contiguous to similar properties.

Drainage is excellent and no claims for damages have been made to date.

(b) - It will also be seen that with [illegible] to [illegible] train movements per day across the Grand Trunk, Niagara Central, [illegible] and Niagara, St. Catharines and Toronto railways, grade separation with these roads were out of the question.

Appendix 4 ..... 4.

Of these crossings the Wabash was the least active, with a regular service of 14 to 15 trains per day, and during the war, an extra traffic of about 15 war special passenger trains per week.

Upon examination of the profile of the disposal railway connecting the main line of the construction road with the disposal grounds and restricted by the controlling conditions (A) and (B) of railway crossings and dump location, it will be fairly established that, to reach the disposal area with 1/2 of 1% grade would be an impossibility on practical and economical grounds, especially when the grade is against the loaded traffic.

This ruling grade would also be a condition prevailing on north and south-bound traffic on the main line tracks, as undoubtedly it would frequently be necessary to operate loaded trains in either direction.

COPY

The profile of the ground, together with the location and grades of the railroads crossing the canal and construction railway, will show that to establish this gradient would involve excessive cuts and fill both north and south of Lundy's Lane and result in difficulties in making connections to service and loading track along the canal.

Again, with shovels working south from the forebay, it is taken, that, in order that the shovels may work to their maximum depths in cuts, both the leads to the main line and the loading tracks are on 1/2 of 1% grade or equivalent. The building of zig-zag lines up the slopes does not appear to be practical, considering that there are ten shovels working all in the same direction and at all points along the line, and when the trains to be handled are over 1,000 ft. long.

Appendix 4 ..... 5.

Shovels working in this way are in the first place operating against drainage and in the second place, will reach their limit of depth of excavation at about 25 ft. below ground for the loading tracks at approximately station 340, or at the north side of the Whirlpool Gully.

Below this depth the grade of 1/2 of 1% will strike rock formation near station 390 and it would be impossible to locate a loading track elsewhere to serve a shovel at that station and at that depth of cut. Neither is there room to switch a 1,000 foot train even on zig-zag tracks, in order to reach the main line.

Between station 210 and 240 it would be impossible to get out with a 1,000 foot train, with cars loaded by shovels having a 10 foot range between shovel and loading track. At these and other points where rock surface projects it would become necessary to increase the grades and load short trains.

To start a 25 car train loaded with 30 cubic yards on each car, requires a draw-bar pull of at least 56,000 lbs. shown by the analysis given below.

The weight of 30 cubic yards of excavation is approximately 40.5 tons and the car 15 tons. A full train of 25 cars will be over 1,400 net tons. With loading track on 1/2 of 1% grade and dirt on the rail, to start the train will require not less than 40 lbs. of draw-bar pull for each net ton of train load (cars and loads included) or a total draw-bar pull of 56,000 lbs.

With an adhesion co-efficient of 22% this calls for a weight of 254,545 lbs. on the drivers of the locomotives or approximately 127 tons, which is a weight far beyond the safe loading limit on construction tracks at dumps and shovels.

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These long trains also entail extensive trackage, requiring long tail tracks both at shovels and dumps.

The conditions under which the proposed units could be utilized may be given in general as follows:

1. That the material excavated is dry and will load on cars with slopes of $1\frac{1}{2}$:1.

2. That the dump or disposal tracks are on tangents, in order that the unloader and plows will work.

3. That unusually long tracks are needed both at dump and to provide for switching, routine of handling unloader and plows, and loading and unloading.

COPY

4. That an average of at least 60 minutes would be needed to unload and release train at the dump, the details of which are given in the following statement:

	TIME
(a) - Upon arrival of the train at the disposal, it is coupled to the plow standing on its spur	3 minutes
(b) - The engine uncoupled and goes for unloader standing on its spur	5 "
(c) - Engine and unloader return and coupled to train	3 "
(d) - Train moved so that unloader is under the cable arm or anchor and cable attached to arm	5 "
(e) - Train moved forward unreeling cable until plow is opposite arm and cable attached to plow	5 "
(f) - Train taken to dump	5 "

<u>Appendix</u> A ..... 2.

These long trains also entail extensive trackage, the idling and wait trains both at shovels and dumps.

The conditions under which the proposed units could be utilized may be given in general as follows:

1. That the material excavated is dry and will stand on cars with slopes of $1\frac{1}{2}$:1.

2. That the dump or disposal ground are so arranged, in order that the unloader and plows will work.

3. That necessarily long tracks are needed both at dump and pit to provide for switching, storing of spotting unloader and plows, and loading and unloading.

4. That an average of at least 40 minutes would be needed to unload and release train at the dump, the details of which are given in the following statement:

<u>TIME</u>

(a) - Upon arrival of the train at the dump, it is coupled to the plow standing on the spur .... 5 minutes

(b) - The engine uncoupled and runs for unloader standing on the spur .... 5 "

(c) - Engine and unloader coupled and coupled to train .... 5 "

(d) - Train moved so that unloader is opposite the cable arm or anchor and cable attached to arm .... 5 "

(e) - Train moved forward unreeling cable until plow is opposite arm and cable attached to plow .... 5 "

(f) - Train taken to dump .... 5 "

COPY

(g) - Train unloaded (plow now next to unloader) .... 20 minutes

(h) - Empties placed on siding .... 3 "

(i) - Plow taken to spur and cable detached from it ..... 5 "

(j) - Unloader taken to spur .... 5 "

(k) - Engine returns and couples to empties .... 5 "

Total time .... 64 "

5. That shorter trains, heavier gradients and lighter locomotives would be necessary to remove the entire earth cut even though it were dry.

Under this routine and system of unloading it will be very difficult to widen the dump at the deep end extreme ends of tracks, for in the first place the yardage per foot of train is smaller, the dump length per train is long, and the plow car being on the end of the train materially shortens the dump each time the track is shifted. This difficulty arises from the restriction due to the varying depths of fill and the limits to dump ground area.

COPY

To widen, it would require that the train be very frequently cut with its attendant delays due to switching out empties, etc.

Should a slide occur on the dump it could not be filled with this equipment, since it will not work when the dump track is on a curve. When the material is unloaded by plow it falls close to the rail and makes operation of train difficult and derailments frequent.

A marked increase in dump force would be needed in order to attend long trains, and for long periods in which the trains are unloading and switching.

This system of handling excavated material is restricted largely to placing ballast on main line tangents or very flat curves and making railroad

APPENDIX "....." D.

(g) – Train unloaded (plow not used in unloading) .... 20 minutes
(h) – Supplies placed on siding .... 7 "
(i) – Time taken to spur and engine detached from it ..... 5 "
(j) – Unloader taken to spur .... 3 "
(k) – Engine returns and couples to supplies .... [illegible] "
Total time .... 64 "

4. That shorter trains, heavier gradients and lighter locomotives would be necessary to remove the entire earth out even though it were dry.

Under this routine and system of unloading it will be very difficult to widen the dump at the [illegible] of trains, for in the first place the yardage per foot of train is smaller, the dump length per train is long, and the plow car being on the end of the train materially shortens the dump each time the track is shifted. This difficulty arises from the restriction due to the varying depths of fill and the limits to dump ground area.

To widen, it would require that the train be very frequently and with its attendant delays due to exchanging out supplies, etc.

Should a slide occur on the dump it could not be filled with this equipment, since it will not work when the dump track is on a curve. When the material is unloaded by plow it falls close to the rail and makes operation of train difficult and derailments frequent.

A marked increase in dump force would be needed in order to attend long trains, and for long periods in which the trains are unloading and switching.

This system of handling excavated material is restricted largely to placing ballast on main line track or very flat curves and making railroad

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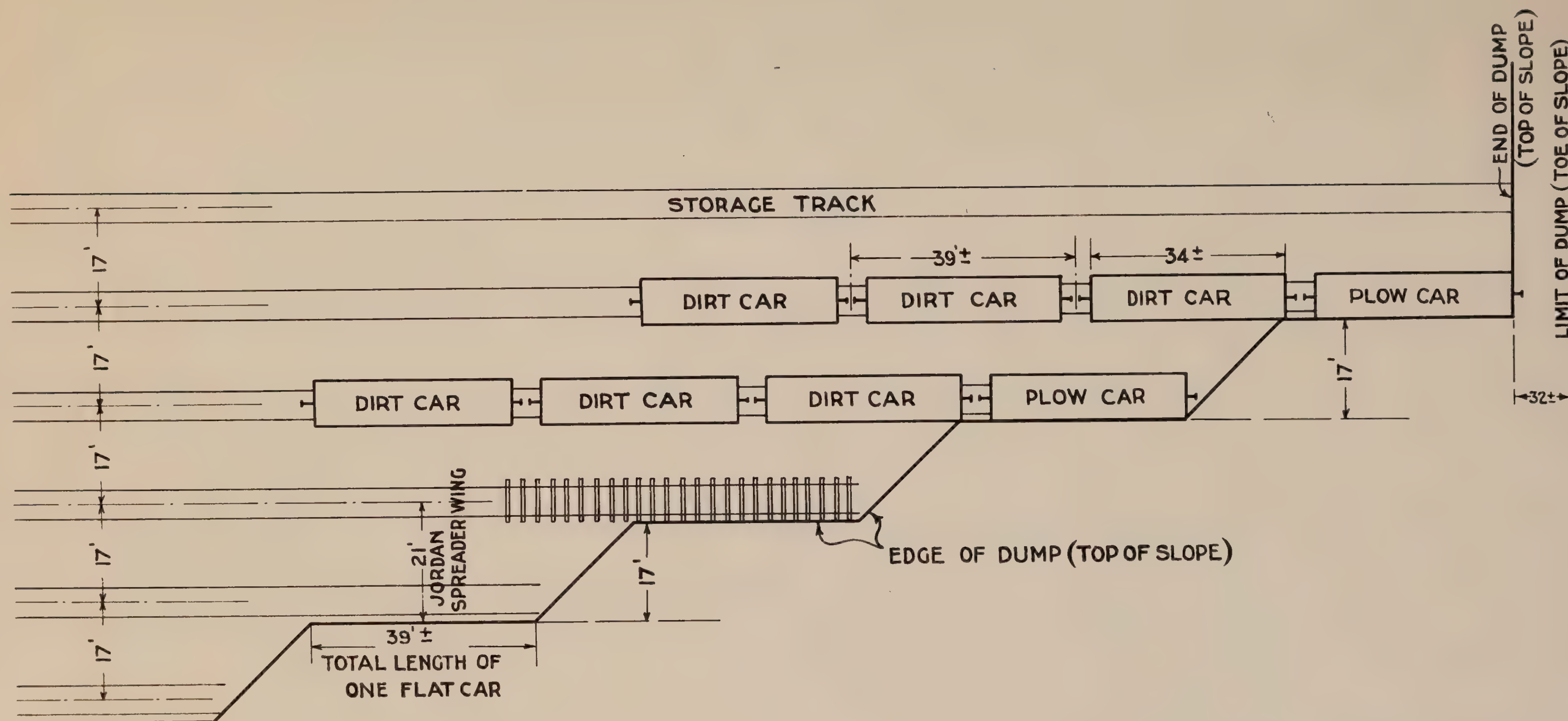
fills from the trestle where the original dump track is not moved and where the tail track is thus unlimited. It was at one time the recognized method of disposing of earth excavation only, on railroad fills, but is now generally superseded by the use of air dump cars. One company's products of dump cars are now in use on 55 prominent railroads of Canada and the United States.

To do the entire excavation in both rock and earth on the canal would, if the earth excavation had been made as proposed, have entailed the equipping of the work with two totally distinct types of excavating plant; one for earth and another for rock.

COPY



APPENDIX 4—CHART A

PLAN SHOWING EFFECT ON DISPOSAL AREA BY USE OF LIDGERWOOD AND PLOW FOR UNLOADING EXCAVATED MATERIAL FROM FLAT CARS WITH HINGED SIDES

June, 1923.

Re-drawn by Walter J. Francis & Company,
Consulting Engineers, August, 1923.

APPENDIX E.

CONSTRUCTION POLICY, ORIGINAL PROGRAM, CHOICE OF PLANT, AND ANTICIPATED PRODUCTION

The growth of the power demand on the Niagara System of the Hydro-Electric Power Commission was such that early in 1914 it became imperative that immediate steps should be taken to secure a further source of power, particularly on account of the fact that the construction of a hydraulic development would take from four to six years to complete, depending on the amount of power involved.

At that time, of the 36,000 cubic feet per second of the Niagara River water allotted to Canada under treaty, there remained 6,500 cubic feet per second available for the Commission. The existing operating plants were then, and are now, only recovering from 135 to 180 feet of the total 326 feet of difference between the levels of Lakes Erie and Ontario, so that with this comparatively limited amount of water it was quite clear that the continued waste of such large percentages of possible head could not be tolerated. It was therefore essential that every possible refinement of design and location should be directed toward the recovery of the last foot of head possible from the gross amount of 326 feet available.

Guided by this principle, in the comparison of the various possibilities of development, the number of feasible propositions was finally reduced to two that had sufficient merit to make them worthy of further study and analysis. These two projects were known as the Jordan-Erie project, and what has now become the Queenston-Chippawa Development.

A P P E N D I X B.

[illegible]

The growth of the power demand on the Niagara System of the Hydro-Electric Power Commission was such that early in [illegible] it became imperative that immediate steps should be taken to secure a further source of power, particularly on account of the fact that the construction of a hydraulic development would take from four to six years to complete, depending on the amount of power involved.

At that time, of the [illegible] cubic feet per second of the Niagara River water allotted to Canada under treaty, there remained [illegible] cubic feet per second available for the Commission. The existing operating plants were then, and are now, only recovering from [illegible] to [illegible] feet of the total [illegible] feet of difference between the levels of Lakes Erie and Ontario, so that with this comparatively limited amount of water it was quite clear that the continued waste of such large percentages of possible head could not be tolerated. It was therefore essential that every possible refinement of design and location should be directed toward the recovery of the last foot of head possible from the given amount of the flow available.

Guided by this principle, in the comparison of the various possibilities of development, the number of feasible propositions was finally reduced to two that had sufficient merit to make them worthy of further study and analysis. These two projects were known as the [illegible] project, and what has since become the Queenston-Chippawa Development.

Appendix 5 ..... 2.

In 1916 surveys of these two projects had been under way for about two years, providing sufficient soundings, borings, contours, etc., upon which to base conclusions as to the relative merits of the two proposals.

The Jordan-Erie scheme consisted in general of an open canal about 24 miles long across the Niagara Peninsula, the intake of which would be at Lake Erie near Morgan's Point, the canal discharging into a forebay on the escarpment immediately above the village of Jordan. From this forebay penstocks over a mile long (representing about 18 feet of penstock per foot of head) would lead the water to the power house situated in the valley below. The tailrace would discharge into the end of the bay at the mouth of the Jordan Creek which is at the level of Lake Ontario.

The Queenston-Chippawa proposal in general took the water from the Grass Island Pool of the Niagara River opposite the mouth of the Welland River near Chippawa, and delivered it to the Niagara River about a mile above Queenston. There were three ways to accomplish this; namely, by the use of a pressure tunnel, by a combined tunnel and canal, and by an open canal.

After careful analysis by the engineers of the Commission and consultations with eminent engineers and contractors, it was finally determined that the open canal would consistently deliver water at less loss under the varying conditions of head, than either of the other two methods, and this was adopted.

The canal scheme of the Queenston-Chippawa Development consisted generally of an intake at the mouth of the Chippawa Creek or Welland River, reversing the flow and canalizing the Welland River for about 4½ miles, from which point an open cut in earth and channeled rock approximately 8½ miles long, led the water

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CONSULTING ENGINEERS

Mr. G. Allan Ross,

Appendix G ..... 2.

In 1912 surveys of these two projects had been under way for about two years, providing sufficient quantity, borings, analysis, etc., upon which to base conclusions as to the relative merits of the two proposals.

The Jordan-Erie scheme consisted in general of an open canal about 11 miles long across the Niagara Peninsula, the intake of which would be at Lake Erie near Morgan's Point, the canal discharging into a forebay on the escarpment immediately above the village of Jordan. From this forebay penstocks over a mile long (representing about [illegible] of penstock per unit of head) would lead the water to the power house situated in the valley below. The tailrace would discharge into the end of the bay at the mouth of the Jordan Creek which is at the level of Lake Ontario.

COPY

The Queenston-Chippawa proposal in general took the water from the Grass Island Pool of the Niagara River opposite the mouth of the Welland River near Chippawa, and delivered it to the Niagara River about a mile above Queenston. There were three ways to accomplish this; namely, by the use of a pressure tunnel, by a combined tunnel and canal, and by an open canal.

After careful analysis by the engineers of the Commission and consultations with eminent engineers and contractors, it was finally determined that the open canal would practically deliver water at less cost under the existing conditions of head, than either of the other two methods, and this was adopted.

The canal scheme of the Queenston-Chippawa Development consisted generally of an intake at the mouth of the Chippawa Creek or Welland River, reversing the flow and canalizing the Welland River for about [illegible] miles, from which point an open cut in earth and excavated rock approximately [illegible] miles long, led the water

to a forebay on the escarpment about a mile above the village of Queenston.

The width of the section of canal in rock was 42 feet with vertical channeled sides and concrete lining on the bottom. The average depth of rock cut was about 40 feet and the average depth of earth overburden was about 40 feet. The maximum rock cut was approximately 70 feet as was also the maximum earth cut. The bottom width of the section in earth was 62 feet with side slopes of 1½:1. Sufficient data was available from the surveys to indicate that the yardage involved for a development utilizing 6,500 cubic feet per second, would be approximately 7,300,000 cubic yards of earth, 2,700,000 cubic yards of rock which included excavation in the power house, forebay, canal and screen house.

The penstocks led directly from the forebay to the power house and were approximately 380 feet long, representing about 1.25 feet of penstock per foot of head. The tailrace from the power house discharged directly into the Niagara River at a level of about 2 feet above the elevation of Lake Ontario, giving a gross head of about 315 feet.

With the intake at the level of Lake Erie and the tailrace at the level of Lake Ontario, the Jordan-Erie scheme would appear at first sight to be the more attractive scheme, but closer studies showed that with an intake on the north shore of Lake Erie, where the prevailing wind was such that, with the induced current of the canal, large quantities of ice would be drawn into the canal, the difficulties of operation would become most serious.

There was also the question of control of about 24 miles of canal and the added difficulties of regulation of flow in penstocks over 5,000 feet long,

and notwithstanding the location of the intake and tailrace being such as to give the maximum possible gross head for the plant, the net amount recoverable was only 297 feet under normal operation conditions. There also remained the very important feature of the conditions for construction. The location of the canal and works was such that these difficulties appeared of real magnitude on account of the lack of railraod facilities and good roads, and the necessity of building a considerably longer construction railroad. In the Queenston project the artificial channel was only 8½ miles long as against 24. The intake was in a location free from possible ice trouble for the greater part of the time, and while the intake was at a point 9 to 11 feet lower than Lake Erie and the tailrace about 2 feet above Lake Ontario, yet with this gross difference of elevation of about 315 feet, the net operating head, after deduction of all losses, was about 305 feet under normal conditions. This particular feature has since become even more important on account of the larger canal capacity subsequently adopted.

The conditions for construction were much more favorable insofar as railroads and better highways were concerned. The location also was closer to the banks and customs offices and was in a more closely settled district, making living conditions more convenient, and its more compact make-up resulted in considerably less construction cost for trackage and disposal of material.

It was therefore decided that the Queenston-Chippawa Development was preferable, and a definite construction problem presented itself for consideration as a result.

Specifications and sufficient general plans were prepared from which it

could be determined whether to contract the work or to execute it under construction forces of the Commission. Contractors were invited to inspect the work, but in consideration of the magnitude of the projects and the necessity of purchasing new, heavy and special construction plant and the need of doing the work under existing war conditions, it became quite evident, in the first place, that no contractor of reputation would bid on anything but a "cost-plus" basis. Furthermore, with the possibility of additional water becoming available through the prospective purchase of the Ontario Power Company and from other sources, it seemed that there might be extensive changes and enlargements in the original plans, in which case the Commission would not have so free a hand, under contract conditions, to make these desirable changes without uncertain and perhaps unusually heavy charges for extras due to changes in plans, and the possible necessity of the contractor purchasing additional and larger units of plant. It thus became evident that ultimate economy and capital cost would be benefitted by unrestricted freedom in making changes in the design.

Another feature which presented itself was that a contractor using the ordinary type of construction plant on this work would not have the advantages of electric power which the Commission had available, and his estimates would therefore have to take into account the greater operating costs for fuel and labor, and the fact that his working season would be limited to 200 days, as against a possible 250 days or 300 days with electric plant. The ultimate economy and capital costs of the development was therefore, largely influenced by the decision of the Commission to do this work with their own construction forces. This contention was borne out in a remarkable manner, for the canal

as built was widened about 8½ feet and deepened a maximum of 12 feet from the original. In addition to this enlargement, the sides were concreted instead of being channeled; the forebay was enlarged and deepened, and the power house and transformer stations were ultimately made a combined building. Had these changes been made under contract it would probably have resulted in the contractor abandoning the work, entailing litigation and heavy indemnities.

Briefly, the controlling conditions which fixed the decision for the performance of the work by the construction forces of the Commission were, the availability of cheap electric power, the use of the heaviest type of excavation equipment, the comparatively convenient disposal grounds for the excavated material, and the advantages of unrestricted freedom in developing the design.

During the early part of 1916 various manufacturers of plant were invited to submit suggestions as to the suitability of the equipment they manufactured, for the work in mind. The result of these enquiries confirmed the opinion of the engineers of the Commission in the choice of the plant as finally purchased.

In general, the major units of this plant consisted of powerful, high lift revolving shovels, electrically operated, for earth and rock cuts of the canal; electric locomotives of approximately 50 tons weight; heavy duty duplex channeling machines; improved modern compressor plant, electrically operated; heavy reinforced type of 20 cubic yard air dump cars; and a high class double track electric railway for the handling of construction material and excavation.

To further confirm the judgment of the engineers in the matter of plant, visits of investigation were made to a number of large projects in the United

States and Canada, the principal of which were, the Calumet-Sag Canal of the Greater Chicago Sanitary District, the levee work on the Mississippi River near Hill-house, Mississippi, which work was being done by construction forces of the United States Federal Government; the Livingstone Channel in the Detroit River, the excavation for which was being done by contract for the United States Government; and the Welland Ship Canal, being completed under contract by the Dominion Government.

On these various works were seen, in actual operation, large type shovels, gantries, draglines, locomotives and compressor plants, a number of which were electrically operated. The high speed cableway at the levee work on the Mississippi was under steam operation, and there were shovels and dredges on the Welland Canal also operated by steam.

COPY

Particular attention is called to the operation of a model 300 Marion steam shovel, doing excavating on section 13 of the Calumet-Sag Canal, which was under contract to A. Guthrie and Sons. This shovel was working in a cut approximately 40 feet deep, of glacial clay, overlying limestone. It was forcibly impressed upon the engineers visiting this work that the conditions here were approximately the same as those which the data indicated for the Niagara work, in that the depth of earth excavation was about equal to the average at Niagara, the material was somewhat similar, and the underlying rock was limestone. This shovel was equipped with an 8-cubic yard dipper, and the superintendent assured us that the engineers had frequently allowed 26 cubic yards bank measurement for three dippers. Apparently, this could be very well credited, as the dipper would come up through the cut heaped up with a solid

cut from the bank. The shovel was served by only two 6 to 7 car trains of 20-cubic yard capacity each, and the dump was only from 12 to 15 feet deep, apparently resulting in considerable delays to train service. The loading tracks were on both sides of the cut and the cycle of digging was about 45 seconds per dipper. It was apparent that had the train service been adequate, this shovel could dig quite easily 6,000 cubic yards in ten hours. The excavated material was such that it did not need rip-rap and no delays could be chargeable to this item.

In the fall of 1916 prices were submitted by various manufacturers covering shovels, locomotives, cars, compressors, etc., and in the spring of 1917 orders were placed for the following shovel equipment:

2 - 225-B Bucyrus electric shovels
2 - 103-C " " "
2 - 18-B " caterpillar revolving shovels.

The 225-B shovel was equipped with 80 and 90 foot booms and 58 foot dipper sticks, with 5 and 8 cubic yard dippers, the former to be used in rock and the latter in earth. The shovel could load cars standing on a track 70 feet above the track of the shovel, thus giving a lift of 80 feet between the shovel track and the dipper, when opened. It had a total rated motor capacity of 578 horsepower and took power from a 4,000 volt line through its own transformers to an operating voltage of 440. The estimated safe capacity of this shovel in rock was 3,000 cubic yards per ten hour day and 5,000 cubic yards in earth per ten hour day.

The 103-C type of shovel was mounted on standard gauge tracks; equipped

Appendix 5 ..... 9.

with 3½ and 4½ cubic yard dippers; loading range in height was 10½ feet from track level to track level, and with a car 8 feet high would load at a maximum height of 18½ feet from shovel track to the bottom of the open dipper. The estimated safe capacity of this shovel in earth was 3,500 cubic yards per ten hour day and 2,000 cubic yards of rock per ten hour day.

The 18-B shovels were purchased largely for preliminary railroad construction and miscellaneous small work. One of these shovels was equipped electrically and the other operated by steam.

Orders were also placed for compressors, cars, locomotives, cableway, etc., but for the purpose of this report it will only be necessary to discuss excavation as affected by shovel operation and compressed air service.

On account of the embargoes placed by railroad companies, and the manufacturing of war munitions in the large centres of United States, it was not until May 1918 that the shovels, as ordered in the spring of 1917, were all put in commission.

The above shovel equipment (4) was bought for the purpose of excavating only from station 60 to 452 on the canal, and a forebay for the development of 6,500 second feet. The first 60 stations of canal being in earth, it was deemed advisable to dredge this, and the power house excavation was to be done by derricks. The schedule chart "A", shows one of the numerous possibilities of removing the yardage of excavation; namely, 7,150,000 cubic yards of earth and 2,290,000 cubic yards of rock, the time limit of which was set for December 31st 1920. The chart was prepared on the basis that the shovel would work day shift only for 250 days per year, for ten hours per day, and that the 250 days would

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best be taken in the period between March 1st and December 31st, the months of January and February being considered unsuitable for economical outdoor work. The capacities of these shovels were fixed from actual records of the manufacturers, and from the actual output as seen on the work of the Calumet-Sag Canal. The Canadian Equipment Company, from whom the shovels were purchased, also indicated in their letter of December 9th, 1919 (file 902) that we were perfectly safe in estimating the capacity of the large 225-B shovels to be 5,000 cubic yards in ten hours. The following is an extract from this letter which assured us of this yardage.

COPY

"This combination with an 8-cubic yard capacity dipper (we figure our dippers water measure, not heaping measure) will give you the maximum capacity, at the same time not sacrifice in reach. We believe that an average of 5,000 cubic yards per day of 10 hours can easily be maintained. In fact, we have records of an average of over 6,000 yards per 9 hour day made with one of our 225-B machines operating in the Pittsburgh-Kansas coal fields in material similar to if not harder digging than that which you will have to handle. This machine also was equipped with a smaller dipper.

"The same boom and dipper handle combination used in their earth section will work out best in the rock section, as can readily be seen by referring to the attached drawing. For the rock work, however, we recommend a 5-yard dipper which will give you an average of 3,500 to 4,000 cubic yards per 10 hour day. It goes without saying, of course, that these capacities are contingent upon the car service."

On page 12 of the Bucyrus bulletin 19-A the following statement appears:

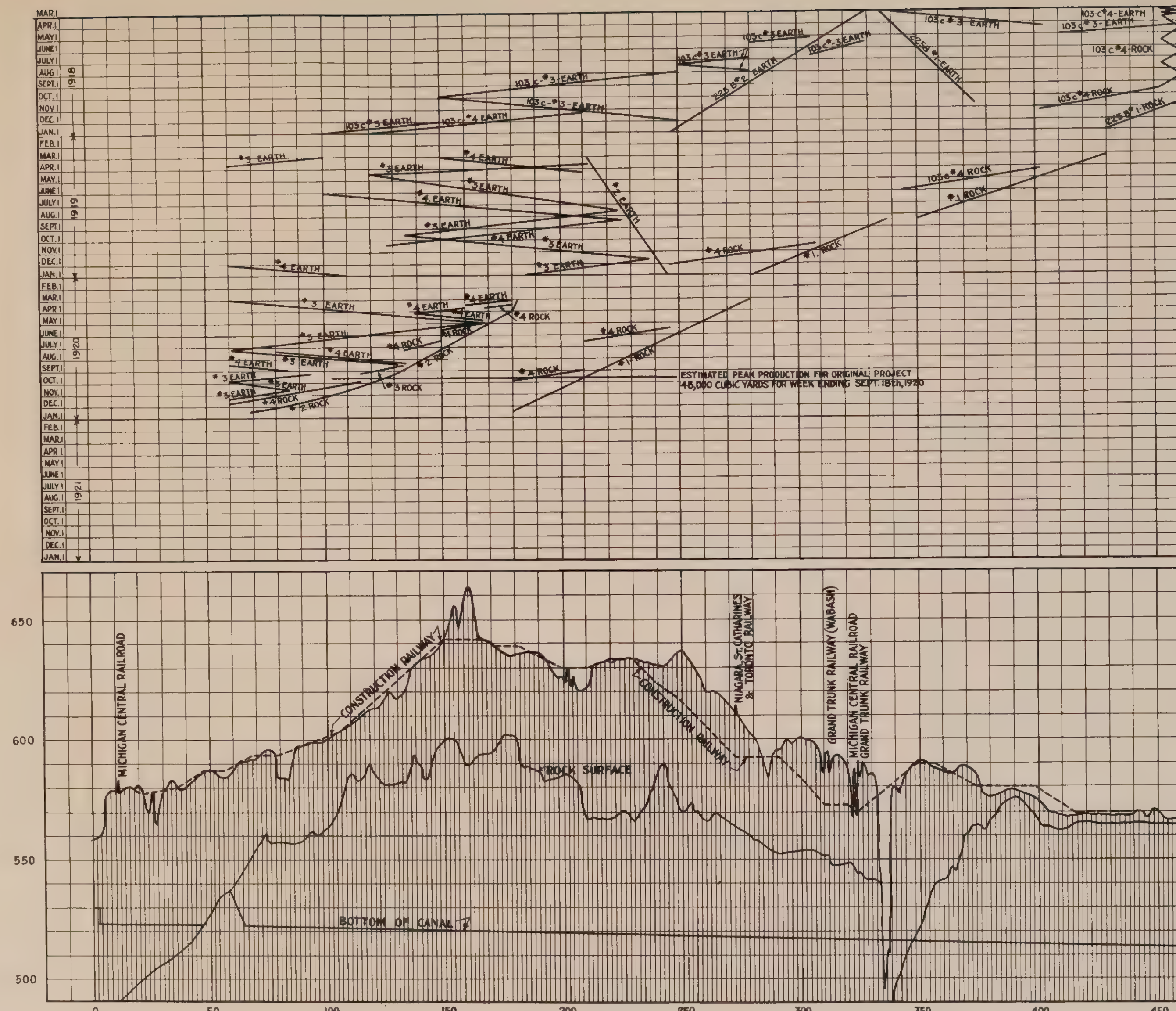
"THE 225-B REVOLVING SHOVEL - The largest of this type - for removing overburden from 15 to 40 feet in depth from horizontal coal veins and from other materials. This shovel has exceptional power and speed of operation, its average capacity being 4,500 to 5,000 cubic yards per nine hours. Its wide reach and high lift make it possible to mine materials economically, impossible to handle by any other method. This also enables it to make one cut, where as standard shovel is obliged to take from 9 to 12 cuts with an equal number of adjustments of the loading track. It is well adapted to stripping coal, from

ore, phosphate rock, zinc, tin, fireclay, talcum, nitrate ore, and similar deposits. It may be operated by electric power where conditions are favorable."

On pages 3 and 6 of bulletin D-3003, appear the following statements under illustrations of one of the shovels operating:

"The speed of operation, and consequent high output, is perhaps the next most important requisite. This has been made possible to the highest degree in this shovel by the following features in design: A boom of a new and improved design which is lighter and stronger than any other yet developed. A shorter revolving frame of light and strong construction. Powerful swinging engines. A single-part hoist which is faster than a three-part hoist. These features enable the 225-B to hoist and swing considerably faster than other shovels of the same size, through requiring less power to start and to stop swinging. This six cubic yard dipper can hold nearly eight cubic yards heaped up. In ordinary digging when the material is overcast, this shovel can average 4,000 to 5,000 cubic yards in nine hours with a six yard dipper. It has even averaged over 6,000 cubic yards in nine hours for a continued run of several days."

"Carney-Cherokee Coal Company's 225-B in a shallow box pit. A 27-D coal loader now replaces the hand labor here shown. This company has two 27-D's. The 225-B has handled 4,500 cubic yards per nine hour day, including all delays and has averaged in a three-day run, 6,028 cubic yards in nine hours."

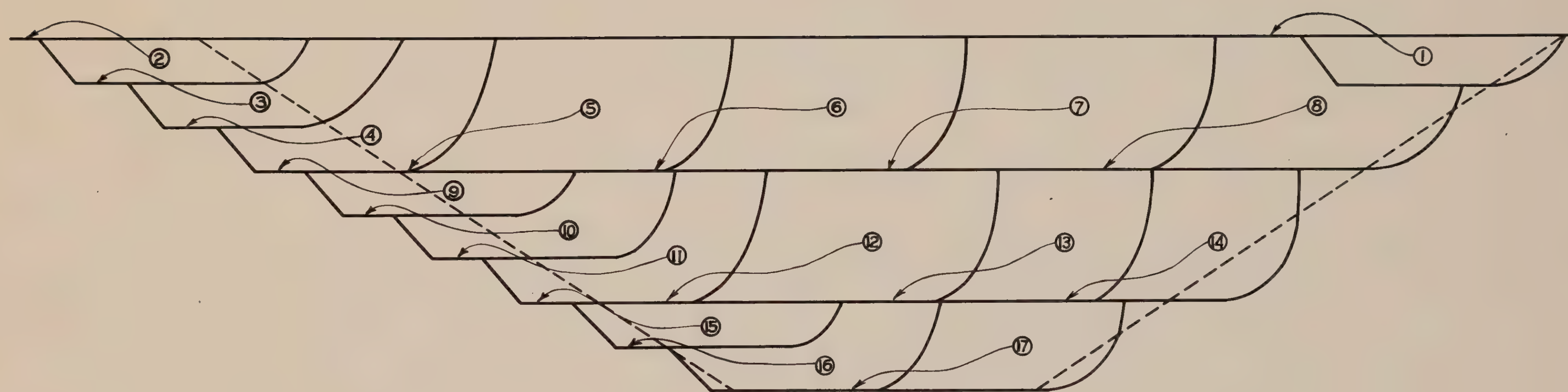


Re-drawn by Walter J. Francis & Company, Consulting Engineers, August, 1923.

APPENDIX 5 - CHART "A"

POSSIBLE SCHEDULE FOR SHOVELS FOR ORIGINAL PROJECT

April 2nd, 1923



NOTE:
MATERIAL TO BE DISPOSED OF TO ONE SIDE ONLY

20 0 20 40

SCALE OF FEET

Re-drawn by Walter J. Francis & Company,
Consulting Engineers, August, 1923.

APPENDIX 6

SEQUENCE OF CUTS BY A 78 C STEAM SHOVEL WORKING IN 72' CUT, 62' WIDE AT BOTTOM, AND SLOPES 1½ : 1

May 30th, 1923.

APPENDIX

ORDER NO.	FIRM	MATERIAL
89	Goodyear Lumber Co.	Hemlock ....
91	" " "	" ....
161	Canadian Equipment Co.	Shovels, dump cars, locomotives
330	F. H. Hopkins and Co.	3 B.C. 40-ton cranes ....
332	" " "	6", 8" and 10" spiral pipe ....
723	Sullivan Machinery Co.	Channelers, compressors, drills, etc. ....
863	Cement Gun Co.	Cement gun repairs ....
1169	Wood Vallance and Co.	Steel Plates ....
1170	" " "	Boiler tubes ....
1235	Baines and Peckover	Mild steel bars ....
1252	" " "	" " plates ....
1270	Gold Car Heating and Lighting Co.	54 car heaters ....
1563	J. J. Gartshore	Angle bars ....
1768	F. H. Hopkins and Co.	Bar bender ....
1785	H. Turnbull & Co.	Track jacks ....
2221	F. H. Hopkins and Co.	1 Jordan spreader ....
2302	Canadian Equipment Co.............	Extra to 103-C shovel ....
2343	Turbine Equipment Co	6 pumps ....
3002	Canadian Equipment Co.	1-103-C elec. shovel .... 1-225-B " " ....
3059	Taylor-Wharton Iron Co.	Dipper teeth ....
3304	Canadian Equipment Co.	2 dipper handles ....
3306	Canadian Westinghouse Co.	Rotor winding ....
3473	A. Leschen and Sons	$2\frac{1}{2}$" lock-bar cable ....
3570	H. Turnbull and Co.	500 boiler tubes ....
3831	Canadian Ingot Iron	Culvert pipe ....
3858	Eastern M'chy. & Equip.	Steam hammer ....
3844	F. H. Hopkins and Co.	Mechanism for $1\frac{1}{2}$ yd. Hayward bucket ....
3985	Canadian Equipment Co.	50 - 16 yd. dump cars ....
2097	Ottis Steel Co.	Boneyard steel plate ....

WALTER J. FRANCIS & COMPANY.

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7.

DATE OF ORDER	SHIPMENT PROMISED	DATE RECEIVED	DELAY
Feb. 12, 1917	Immediate-Stock	Comp. Feb. 17/19	App. 2 yrs.
"	" "	" Apr. 15/18	14 months
Mar. 28, 1917	Partial stock	Shipment comm. Aug. 12, 1917-Comp. Jan. 1/18	App. 6 mos.
May 28, 1917	2 weeks	Feb. 18, 1918	8 months
"	10 weeks	Dec. 2, 1922	5½ years
Jan. 18, 1917	July, 1917	Aug. 1, 1918	1 year
Sept. 24, 1917	Stock	Nov. 1, 1917	5 weeks
Nov. 1, 1917	"	Apr. 25, 1918	6 months
"	"	July 18, 1918	9 months
"	"	Nov. 19, 1918	12½ months
Nov. 5, 1917	4 weeks	Dec. 5, 1918	13 "
Nov. 9, 1917	4 "	Feb. 2, 1918	2 "
Dec. 19, 1917	No promise	Mar. 23, 1918	3 "
Jan. 19, 1918	6 weeks	May 9, 1918	11 weeks
"	5 days	Feb. 19, 1918	3 "
Mar. 16, 1918	Stock	May 18, 1918	2 months
Mar. 20, 1918	"	July 30, 1918	App. 3 mos.
Mar. 25, 1918	"	July 12, 1918	4 months
July 5, 1918	Dec. 28, 1918	Mar. 29, 1919	3 months
"	"	Apr. 9, 1919	3½ months
"	No promise	Oct. 16, 1918	3 months
Aug. 8, 1918	-	Mar. 25, 1919	App. 6 mos.
"	No promise	Jan. 5, 1919	5 months
Aug. 22, 1918	Stock	Nov. 22, 1918	3 months
Nov. 8, 1918	1 week	Dec. 17, 1918	1 month
Sept. 30, 1918	1 "	Dec. 29, 1918	3 months
Oct. 8, 1918	Stock	Nov. 13, 1918	5 weeks
Oct. 3, 1918	3 weeks	Apr. 5, 1919	6 months
Oct. 16, 1918	March, 1919	Sept. 26, 1919	6 "
Nov. 2, 1918	Stock	Feb. 10, 1919	13 weeks

WALTER J. FRANCIS & COMPANY.

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Cost Department - July 11/23.

APPENDIX 8.

Total Cost of 10 Units .... $ 82,000,000.00

Less Permanent Hydraulic, Electrical & Other Machinery Contracts .... $ 13,238,334

Less Contracts for Intake & River, Etc. 1,000,000

Less Cement .... 3,000,000 .... 17,238,334.00

Net Total of Actual Construction Expenditures ....$ 64,761,666.00

COPY

Total "Contractors Plant" Investment 9,804,732.81

Ratio of Construction Plant to Constructions Expenditures = 15%

In this $9,804,732.81 of Construction Plant we have a Labor factor for Assembling of Plant Structures of $1,900,000 which would not be considered as actual "Contractors Plant" as purchased, and if this were deducted from the Plant Account it would leave a balance of $7,904,732.81, and a ratio to construction of 12.2%.

A P P E N D I X 8.

Cost Department -
July 11/23.

INVENTORY OF "CONTRACTORS PLANT" USED
USED ON THE NIAGARA DEVELOPMENT

PLANT	ORIGINAL COST		BOOK VALUE MARCH 31, 1922
Shop Cranes	23,124.98	.....	4,002.00
Storage Batteries & Small Motors	17,072.77	.....	666.00
Sundries	22,058.69	.....	870.00
Shovels	1,087,539.55	.....	277,738.00
Channelers	147,746.71	.....	37,807.00
Drills (Tripods, Submarine, Etc.)	284,351.08	.....	65,250.00
Compressors including Motors Etc.	352,607.07	.....	108,750.00
Cableway	66,173.83	.....	34,800.00
Electric Locomotives	930,049.42	.....	396,587.00
Steam Locomotives	337,902.71	.....	158,089.00
Dump Cars, Incl. Flat, Box & Ballast Cars	1,432,475.33	.....	403,300.00
Dump Wagons	9,502.85	.....	1,305.00
Hauling Trucks	21,454.13	.....	2,510.00
Tractors	12,515.17	.....	1,044.00
Hoists & Derricks Incl. Motors	364,920.79	.....	87,000.00
Locomotive Cranes	199,044.01	.....	102,374.00
Crushers) Conveyors)	235,079.74	.....	61,187.00
Concrete Plants Including Motors, Etc.	2,703,214.06	.....	113,330.69
Machine Tools (Machine shop equipment)	100,191.32	.....	30,450.00
Woodworking Machinery	13,868.94	.....	3,480.00
Misc. Plant (Gen. Equipt.)	519,921.03	.....	69,600.00
Transformers	68,892.31	.....	19,575.00
Pumps (Incl. motors, etc.)	185,988.64	.....	43,500.00
Tanks	39,418.94	.....	1,740.00
Autos & Trucks	153,617.12	.....	71,695.00
Horses & Stable Equipt. Etc.	22,403.88	.....	2,610.00
Rented Plant	453,597.74	.....	-
TOTAL PLANT	$9,804,732.81	....	$2,099,459.69

APPENDIX 9.

COMPARATIVE COSTS OF STEAM AND ELECTRIC SHOVELS.

Quotations were obtained from the Bucyrus Company in 1916 on both steam and electrically operated shovels of the type 103-C. The electric shovel at $40,910.00, and the steam shovel at $24,305.00, or a ratio of 1 to 1.68.

Under order dated March 23th, 1917, purchase was actually made of one 18-B steam and one 18-B electric shovels from the Bucyrus Company. The electric shovel was purchased at $15,732.00 and the steam shovel at $10,805.00.

In 1918 electric shovel No. 3 (225-B) was purchased at $152,000.00. In 1920 No. 11 steam (Marion 300) was purchased at $145,649.00 and No. 12 (Bucyrus 225-B, steam) was purchased at $138,072.00.

By referring to the chart of price variation between 1918 and 1920, it shows a relation of 250 for 1918 and 300 for 1920. Applying this factor, No. 11 becomes $121,000.00 at 1918 prices and No. 12 becomes $115,000.00 at 1918 prices.

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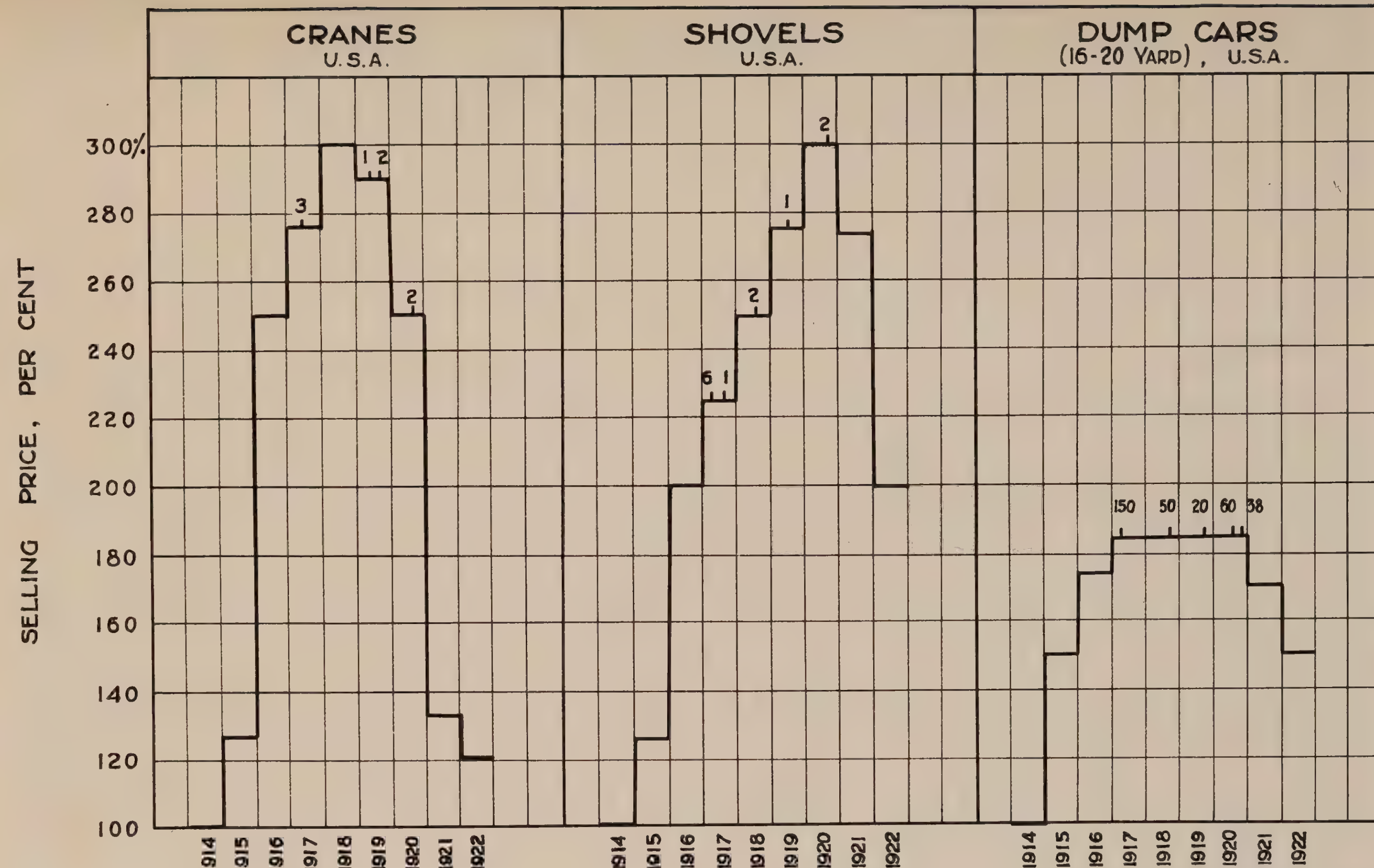
STEAM SHOVELS			ELECTRIC SHOVELS			
DATE OF ORDER	NUMBER	COST	DATE OF ORDER	NUMBER	COST	RATIO
-	-		Mar.28,1917	No.1-225-B	$88,000.00	
-	-		"	No.2-225-B	88,000.00	
-	-		"	No.3-103-C	43,865.00	
-	-		"	No.4-103-C	43,865.00	
Mar. 28,1917	No. 5-18-B	$ 10,803.00	"	No.6- 18-B	15,732.00	1:1.46
-	-		July 6,1918	No.8-225-B	152,000.00	
-	-		"	No.9-103-C	73,875.00	
Jul.12,1920	No.11-300 M	145,649.00	-	-	-	
Aug.14,1920	No.12-225-B	138,072.00				
For 1918 price	No.11-300 M	121,000.00	July 6,1918	No.8-225-B	152,000.00	1:1.26
"	No.12-225-B	115,000.00	"	"	152,000.00	1:1.32
Quoted, 1916	103-C	24,316.00	Quoted, 1916	103-C	40,910.00	1:1.68

COPY

The average ratio = 1:1.43, or the electric shovels cost about 43% more than the steam.



FIGURES REPRESENT NUMBER PURCHASED
DOTS REPRESENT APPROXIMATE PURCHASE DATE

Re-drawn by Walter J. Francis & Company
Consulting Engineers August, 1923.

APPENDIX 9

VARIATION IN PRICES 1914-1922

June 22nd, 1922.

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

APPENDIX 10. Sec. 1.

EXTRACTS FROM COST REPORTS MADE TO H.G. ACRES BY A. G. BRADLEY, COST ACCOUNTANT, DURING THE COURSE OF THE WORK, AND REFERRING TO THE PROVEN SUPERIORITY OF THE LARGE ELECTRIC SHOVEL, IN THE MATTER OF PRODUCTION AND UNIT COST, OVER THE RAILWAY TYPE OF SHOVEL.

COMMENTS FROM REPORT OF APRIL, 1920

(Re: Large Electric vs. Small Railway Type Shovel)

COPY

Earth and rock costs in the intervening time between 1917 and 1920 have had strike advances, not only applying to common labor but also to all the trades, and apart from that, several particular classes, working over eight to twelve hours, demanded double time for the extra two or four hours, as the case may have been. These rising conditions in the labor market show 67% advance over 1917, but instead of the labor cost of a cubic yard of earth and rock rising in unison with the man's pay, we have, at this date, a proven fact which shows conclusively that the predecision of those who shaped the Hydro policy of plant requirements in the earth and rock excavation has been amply vindicated by the success of the large 8-cubic yard type of electric shovels.

This is all the more commendable in the face of the then radical change in size, and the fact that electricity was to be the motive power, which in both cases was a radical departure over the type of shovel then in general use by contractors. Those who witnessed the different behaviour in quicksand of the two classes of shovels, soon realized that if the small railway type shovels had

A P P E N D I X 18. No. 1.

EXTRACTS FROM COST REPORTS MADE TO R.S. ACHES BY A. G. BRADLEY, COST ACCOUNTANT, DURING THE COURSE OF THE WORK, AND PERTAINING TO THE PROVED SUPERIORITY OF THE LARGE ELECTRIC SHOVEL, IN THE MATTER OF PRODUCTION AND UNIT COST, OVER THE RAILWAY TYPE OF SHOVEL.

EXTRACTS FROM REPORT OF APRIL, 1920

(Re: Large Electric vs. Small Railway Type Shovel)

Earth and rock costs for the intervening time between 1917 and 1920 have had startling advances, not only applying to common labor but also in all the trades, and apart from that, several particular classes, working over eight to twelve hours, demanded double time for the extra two or four hours, as the case may have been. These rising conditions in the labor market show 67% advance over 1917, but instead of the labor cost of a cubic yard of earth and rock rising in unison with the men's pay, we have, at this date, a proven fact which shows conclusively that the predecision of those who adopted the [illegible] policy of plant requirements in the earth and rock excavation has been amply vindicated by the success of the large 5-cubic yard type of electric shovels.

This is all the more commendable in the face of the then radical change in size, and the fact that electricity was to be the motive power, which in both cases was a radical departure over the type of shovel then in general use by contractors. Those who witnessed the different behaviour in placement of the two classes of shovels, soon realized that if the small railway type shovels had

been forced to take out the deep excavation in successive lifts, working in quicksand all the time, with the serving train beside them, the saving in cost per cubic yard as seen on yearly chart attached, as well as the saving in total dollars, would never have been realized, as it actually was by the decision to use the balanced quota of large and small shovels as purchased, rather than all of the small railway type.

This balanced quota worked out admirably well, the small railway type removing the <u>top dry cutting</u>, and the large electrics removing the narrow deep 70 foot cuts of <u>water saturated sand</u>, while standing on rock bottom, and loading trains 70 ft. above on <u>well ballasted dry loading tracks</u>.

In order to clearly describe our pumping or unwatering difficulties it would first be well to understand the sand formations of the locality through which the canal passes.

Practically the entire township of Stamford is sand of a very fine nature, and especially so in the vicinity of our canal excavation. About five miles of the canal centre section is located in a basin of depressed rock where, previous to the opening up of cuts along the route, water seemed to maintain a certain level within a few feet of the ground surface, and as soon as a cut was started in this area by our shovels, this water made an absolute quicksand mire out of the material being excavated. In this large area the small shovels proved absolutely useless, with the exception of the southern extremity from Lundy's Lane, where the top dry cutting was removed by them. Our only salvation in this area lay in the large shovels, and their ability to dig down to rock foundation.

The difficulties to overcome in this area were tremendous, and affected

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

the costs of 1919 and 1920 earth excavation to a great extent, especially when it is understood that this battle against water, slides, and quicksand extended over approximately one-half of our canal earth, not in any minor way, but in a very appreciable way, as related to cost fluctuations, especially to those of the large electric shovel.

EXTRACT FROM REPORT MADE IN 1919

(Re: Large Electric vs. Small Type Shovels)

The carrying out of this undertaking is demanding a trial of some of the newest, best equipped, and nicest working excavating plant in the world at this time. This plant as well, has proven its superior efficiency by reason of its well balanced nature for this particular work, over what we would have experienced had we adopted the methods of the present known large excavation contractors. I know of no large contractor with whom I have had business relations who could, or would, have undertaken this work and successfully carried it out under the plan they would have adopted; namely, the use of the small railway type steam shovels with which they are at present equipped, and which they would probably insist on using, owing to the higher investment cost, and to a natural aversion to the electric shovel on account of a prevailing general belief that the electric is slow. The common practice among contractors is to excavate the top cut in earth where they could make easy money, and which they would be forced to do here, but the second de th cutting would find this type of shovel

hopelessly wallowing in quicksand and the Commission would, ere this, have been faced with an admission of inability, on the part of the contractor, to carry on to completion even the earth work, and undoubtedly the Commission would have been called upon to finance the balance of the work, and be burdened by having to take over a junk contractor's plant as partial security.

Knowing the proven results, and success of the large electric shovels and their electric hauling equipment, and knowing the radical change this equipment has meant over the old types of contractor's plant, one can feel a keen admiration for those who made the decision to use this new plant. Praise is also due to the mechanical ability that experimented with and rebuilt the original large shovels after their introduction on this development, as the first two were more or less remodelled, by the Construction Department, to meet the special conditions on this work.

COMMENTS ON YARDAGE OUTPUT UP TO JULY, 1919
WITH ATTACHED TABLES NOS. 2 and 2-A.

A reference to, and comparison of the two tables attached, will show our excavation of earth has far outclassed the Welland Ship Canal in the higher average of shovel efficiency figures. We are taking out more yardage per one cubic yard bucket capacity employed per ten hours, notwithstanding our quicksand troubles, which in the main, I think will overbalance their heavier class of material, which was a greasy clay.

A study of table No.2 will show that the large Bucyrus-8 cubic yard type is giving the highest results in yardage excavated in the six months of 1919,

where it will be seen that the greatest yardage, with the best average per one cubic yard per ten hours, was accomplished; the figures showing 1,146,338 yards excavated and 279 for the efficiency comparison. Furthermore, as against an average efficiency figure of 200 per one cubic yard bucket per ten hours for shovels on the Welland Canal, the average of our smaller type railway shovels show an efficiency figure of 266.

The accompanying chart further amplifies the comparison of the large electric shovels, as against the smaller railway type, in the matter of cost per cubic yard of production.

This chart shows that the railway type shovel was employed to the maximum that was possible for this shovel to work in dry material; namely, a total of 39% of the whole earth excavation, but at a cost much higher than the large electrics, even considering the fact that the railway type shovel worked always in top dry cutting, with the short lift to trains, while the large electrics were always in the quicksand with up to a 70 foot lift to trains.

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

Appendix

Table No. 2.

RECORD OF COMPARISONS IN SHOVEL EFFICIENCY,- TH
YARDAGE FROM THE START OF WORK ON HYDRO CANAL,-
1 CY. CAPACITY SO THAT A COMPARISON OF THEIR ACTU

COPY

Shovels	Type & Capacity	No. 10 Hr. Shifts Employed on 1 CY. Basis 1917	Yardage 1917.	Unit of Eff. Comp. 1917	No. 10 H Shifts Employed 1 CY. Basi 1918
Shov. #1	225B-8 Cy.	-	-	-	2400
" #2	" "	-	-	-	1600
" #8	" "	-	-	-	-
Total of this type for periods					4000
Shov. #3	1030-3½ Cy.	45	9236	205*	1312
" #4	" "	-	-	-	567
" #9	" "	-	-	-	-
Total of this type for periods		45	9236	205*	1879
Shov. #5	18B-3/4 Cy.	131	52590	401*	225
" #6	" "	13	5750	427*	225
Total of this type for periods		144	58340	405*	450
Shov. #7	Steam 2½ Cy.	500	140605	281*	625
" #10	" 1 "	-	-	-	-
Total of Steam for periods		500	140605	281*	625
Dredge	5 Cy.	-	-	-	436
Cableway	3 "	-	-	-	450
T O T A L		689	208181	302*	7839

(* denotes figures shown in red in Mr. Acres's report. W.J.F.)

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

ction 1

Cost Department, July 1919.

PORT IS A COMPILATION OF THE RECORDS IN EARTH
L SHOVELS ARE BROUGHT TO A COMMON DENOMINATOR OF
FICIENCY MAY BE SEEN INDIVIDUALLY AND BY TYPE

rdage 918.	Unit of Eff. Comp. 1918	No. 10 Hr. Shifts Employed on 1 CY. Basis 1919	Yardage 6 Mos. 1919	Unit of Eff. Comp. 1919	TOTAL AVERAGE EFF.
3595	211*	1416	449168	317*	251*
7167	211*	2400	635291	265*	243*
-	-	296	61879	209*	209*
5762	211*	4112	1146338	279*	246*
3016	219*	25[illegible]	[illegible]4232	171*	211*
3663	192*	304	9911	114*	136*
-	-	371	194722	525*	525*
5679	211*	934	248865	266*	229*
9956	239*	117	28484	243*	285*
3979	191*	122	32149	264*	225*
0035	215*	239	60633	253*	259*
174	54*	32	16497	515*	165*
-	-	20	1477	73*	73*
174	54*	52	17974	345*	164*
0050	237*	375	109511	292*	262*
3970	142*	900	177560	197*	178*
5570	197*	6612	1760881	267*	232*

COPY

: To arrive at machines daily average for above periods multiply the Unit of Efficiency by the corresponding dipper capacity.

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

Table No. 2-A.

Cost Department,
July 1919.

WELLAND SHIP CANAL

COMPARISONS OF SHOVEL EFFICIENCY.

				SHOVEL EFFICIENCY		
B.Y. & H.	- 3½ c.y.	steam shovel, Bucyrus	....	217	1,889	c.y. per 10 hrs.
"	- 3½ c.y.	" dragline "	....	123	1,072	" " " "
S. & R.	- 2½ c.y.	" Atlantic shovel	....	240	1,720	" " " "
Y. & R.	- 2½ c.y.	" dragline, Bucyrus	..	167	1,207	" " " "
H. & L.	- 2½ c.y.	" shovel "	..	184	1,323	" " " "
D.D.Co.	- 2½ c.y.	" dragline "	..	125	1,086	" " " "
"	- 2½ c.y.	" Marion Osgood shovel	....	160	1,157	" " " "

Average efficiency of shovels 200

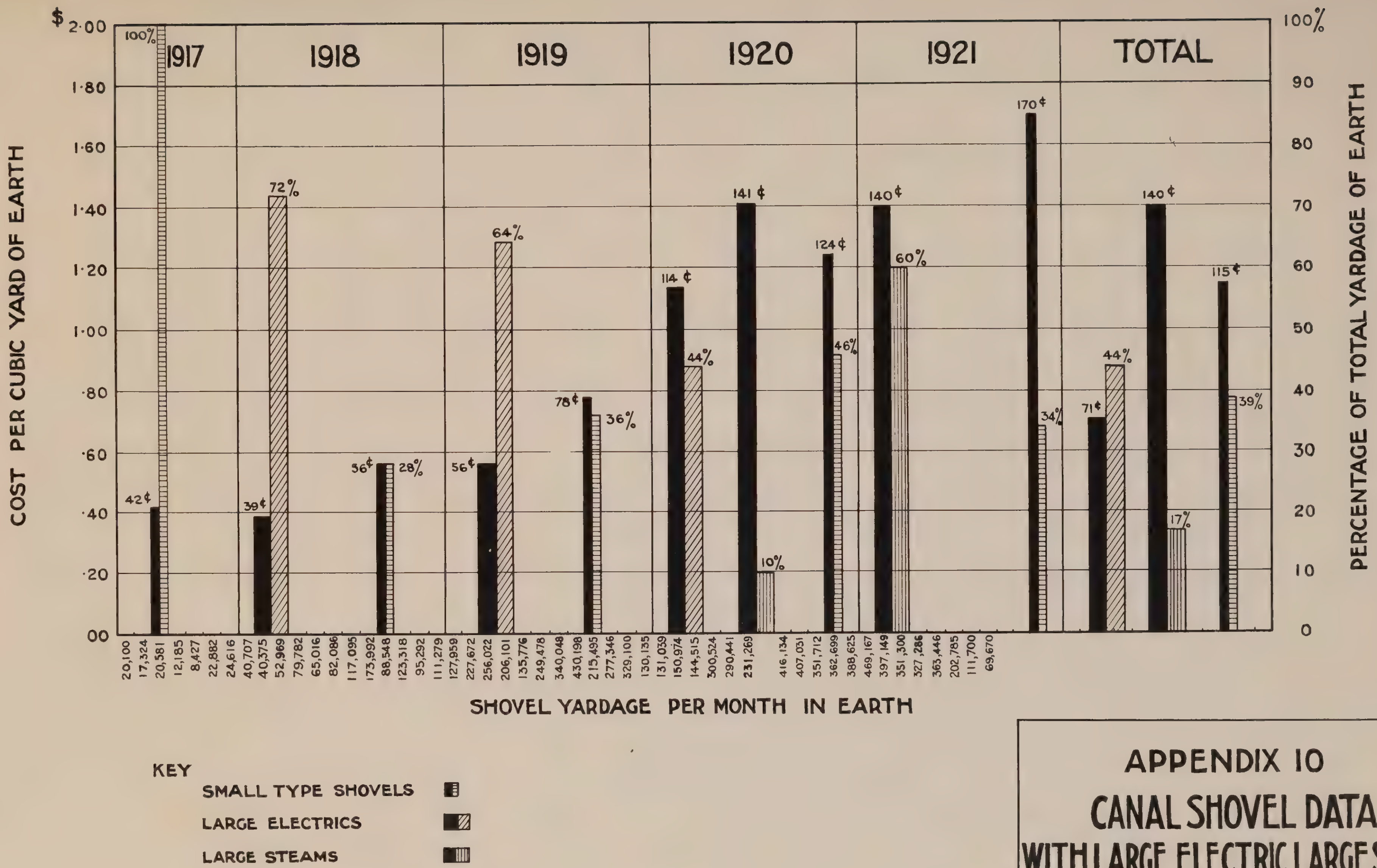
" " " dragline 138

The above records for shovels and draglines cover 4,500,000 cubic yards of earth excavation.

COPY

APPENDIX 10

CANAL SHOVEL DATA WITH LARGE ELECTRIC, LARGE STEAM AND SMALL TYPE SHOVEL COMPARISONS



Re-drawn by Walter J. Francis & Company, Consulting Engineers, August, 1923.

A P P E N D I X 10. Sec. 2.

ATLANTIC STEAM SHOVEL NO. 7 VS ELECTRIC SHOVEL NO. 3.

The Atlantic steam shovel No. 7 was purchased second-hand at the beginning of the work and was equipped with a 2½ cubic yard dipper.

Electric shovel No. 3 was purchased new at the beginning of the work and was equipped with 3½ and 4½ cubic yard dippers.

These shovels will be compared in earth excavation only; No. 3 from October 1919 to March 1921, inclusive, omitting March 1920 (in rock) and June and July 1920 (strike); and No. 7 from July 1919 to March 1921, inclusive, omitting June and July 1920 (strike). These periods are taken when both shovels were in as similar conditions of both time of year and material of excavation, as could be obtained.

The conditions in rock excavation were not equal or similar at any one period when both shovels were working.

No. 3 encountered some wet digging during its period and also some excavation which, while classified as earth, was mixed with some rock, as in February, 1920. It was also dismantled and re-erected in February 1920, for moving from Division No. 3 to No. 2.

On account of No. 7 shovel being purchased second-hand at pre-war price, the depreciation and interest charges were relatively small compared with those against electric shovel No. 3, purchased new under war conditions.

The total interest and depreciation charge against No. 3 for the full

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COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

Appendix 10 ..... 2.

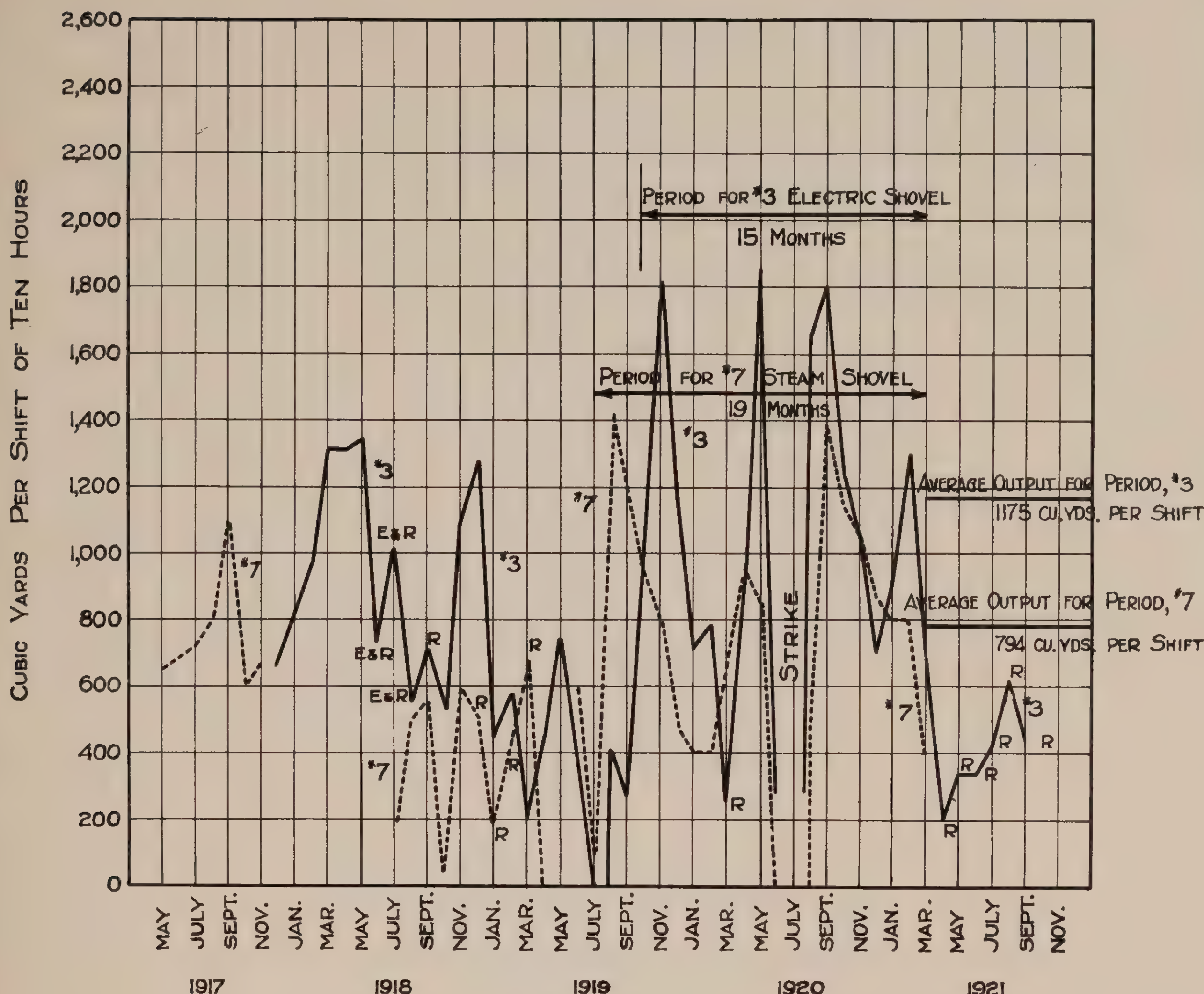
period was $31,279.00 which included the depreciation chargeable to rock in March 1920. Deducting this, there remains a charge of 3.4 cents per cubic yard against earth for the 15 months that this shovel was in earth excavation.

The total interest and depreciation charged against No. 7 for 22 months, beginning June 1919, was $ 12,154.50 which is a charge of 1.7 cents per cubic yard for earth excavation, or a difference of 1.7 cents per cubic yard.

The output of No. 3 for the 15 months was 831,115 cubic yards, or 1175 cubic yards per shift of ten hours, at a cost of $1.016 per cubic yard, and for No. 7 for 19 months was 714,540 cubic yards or 794 cubic yards per shift at a cost of $1.14 per cubic yard.

COPY

Placing these values on the same basis of depreciation and interest, the cost of No. 3 becomes 99.9 cents and No. 7 - $1.14. Thus, No. 3 takes out 150% of the yardage of No. 7 and at 88% of the cost of No. 7; or, looking at the situation in another way, No. 3 takes out 171% of the yardage of No. 7 on the basis of equivalent cost; and this while handicapped by some wet digging, some mixed earth and rock excavation, and the cost of dismantling and re-erecting in February 1920.



Re-drawn by Walter J. Francis & Company,
Consulting Engineers, August, 1923.

APPENDIX 10

CHART SHOWING RELATIVE OUTPUTS PER SHIFT OF TEN HOURS OF Nos 3 AND 7 SHOVELS

June, 1923.

APPENDIX 10, Sec. 3.

STEAM VS ELECTRIC SHOVEL IN EARTH EXCAVATION
COMPARING NO. 8, 225-B ELECTRIC AND
NO. 12 - 225-B STEAM

Shovel No. 8 worked in earth excavation of canal during the months June to December 1920, inclusive, and in January 1921, and No. 12 during December 1920 and January to April 1921, inclusive. These are the only two periods during which both shovels were working in earth that have conditions as nearly as possible comparable. The months of June and July, 1920 are omitted on account of the strike which created an abnormal condition.

The following statement shows the output, number of shifts, cost per cubic yard, height lifted, etc., for both shovels for the months specified:

SHOVEL NO. 8 - EXCAVATION VERY WET

MONTH AND YEAR	CUBIC YARDS	NO. OF SHIFTS	C.Y. PER SHIFT	TOTAL COST	UNIT COST	HEIGHT LIFTED	MAN HR. RATE
Aug. 1920	124,468	52	2,390	119,484.81	.960	47'	61¢
Sept. "	161,601	50	3,230	134,126.54	.830	50'	62.5¢
Oct. "	121,730	48	2,535	126,220.36	1.046	37'	63.2¢
Nov. "	78,272	50	1,565	91,459.86	1.170	39'	63.8¢
Dec. "	90,596	51	1,775	112,170.93	1.240	42'	63.2¢
Jan. 1921	122,956	44	2,795	160,500.15	1.316	48'	62.2¢
Total or Average	699,633	295	2,380	743,962.65	1.063	44.5'	62.6¢

Appendix 10 ..... 2.

SHOVEL NO. 12 - EXCAVATION MORE NEARLY NORMAL

MONTH AND YEAR	CUBIC YARDS	NO. OF SHIFTS	C.Y. PER SHIFT	TOTAL COST	UNIT COST	HEIGHT LIFTED	MAN HR. RATE
Dec. 1920	73,150	50	1,503	109,824.97	1.460	39'	63.2¢
Jan. 1921	85,869	50	1,717	130,544.51	1.520	47'	62.2¢
Feb. "	108,695	44	2,470	141,638.21	1.300	34'	62.0¢
Mar. "	121,931	56	2,175	171,134.73	1.400	43'	62.5¢
Apr. "	137,854	54	2,550	186,705.73	1.360	40'	61.6¢
Total or Average	529,499	253	2,093	739,848.15	1.397	40.8'	62.3¢

The conditions for No. 8 shovel around station 200 to 235 were unusually wet, requiring extra batteries of pumps. This shovel was forced back several times by sliding banks, and seriously delayed in consequence.

No. 12 did not encounter nearly so bad ground, as it was near the peak of rock, giving better drainage and drier digging.

The tabulation shows that No. 8 took out 113.5% of the output per ten hour shift of No. 12 and at 76.1% of the cost per cubic yard, or 150% more output than No. 12 on the basis of <u>equivalent cost</u>.

The height lifted by No. 8 was 44.5 ft. against 40.8 ft. for No. 12, or 3.7 ft. of lift in favor of No. 12.

From a comparative test of electric and steam shovels in rock cut, it was found that a difference of 18 ft. in lift effected an increase of 24% in actual digging time, or of output, so that a drop of 3.7 ft. of lift should show approximately 5% increase in the output. Therefore, for the same lift No. 8 would take out 5% more than when in deep cut; i.e., the equivalent output of

Appendix 10 ..... 3.

No. 8 at the same cost and same lift would be $\frac{105}{100}$ x 150% = 157.5% of the output of No. 12 for the same cost, notwithstanding the unusually treacherous bank and wet digging it encountered.

To illustrate the serious handicaps that No. 8 shovel had, the following are extracts from the daily shovel reports and will indicate to some extent the difficulties encountered:

August 5th,	1920	....	Digging out track.
" 9th,	"	....	" " "
" 16th,	"	....	" " shovel - off track.
" 24th,	"	(day) .	" shovel out of mud.
" 24th,	"	(night)	" in 4 ft. of water.
" 25th,	"	....	Water high, building dam.
September 1st,	1920	....	Building dam behind shovel.
" 13th,	"	....	Digging shovel out of mud.
" 25th,	"	....	Moving back to rip-rap pit.
October 5th,	"	....	Jacking shovel to get tracks under.
" 7th,	"	....	" " " " " "
" 18th,	"	....	Digging out pontoons.
" 29th,	"	....	Loading track caved in.
November 3rd,	"	....	Digging shovel out of mud.
" 4th,	"	....	Clearing tracks to move up.
" 17th,	"	....	Loading track caved in.
December 6th,	"	.....	Pulling pontoons.

Note that references to severe conditions of wet digging are not in evidence as No. 8 approaches the position where No. 12 started in. No further reference to unusual conditions appears after December 6th.

Regarding No. 12 there are only two items in this reference that may be taken to indicate the presence of extraordinarily wet digging; namely,

December 13th,	1920	....	Flooded - water
February 25th,	1921	....	Pontoons
" 26th,	"	....	Moving pontoons.

Appendix II ..... 3.

No. 8 at the same cost and rate would be $\frac{125}{108}$ x 18½ = 107.5% of the output at No. 12 for the same cost, notwithstanding the extremely troublesome mud and wet digging it encountered.

To illustrate the various conditions that No. 8 shovel had, the following are excerpts from the daily shovel reports and will indicate in some degree the difficulties encountered:

August 8th, 1920 ...... Digging out track.
" 9th, " .... " " "
" 16th, " .... " shovel - off track.
" 24th, " (day) . " shovel out of mud.
" 24th, " (night) " in 4 ft. of water.
" 28th, " ...... Seven high, building dam.
September 1st, ... Digging dam behind shovel.
" 13th, ... [illegible]
" 17th, ... [illegible]
October 5th, " .... Jacking shovel to get track under.
" 6th, " .... " " " " " "
" 12th, " .... Digging out pontoons.
" 23rd, " .... Loading track moved in.
November 2nd, " .... Digging shovel out of mud.
" 4th, " .... Cleaning tracks to move up.
" 15th, " .... Loading track moved in.
December 2nd, " .... Pulling pontoons.

This ... [illegible] at No. 8 [illegible] and no further reference to unusual conditions appears after December 6th.

Regarding No. 12 there are only two items in this reference that may be taken to indicate the presence of [illegible] wet digging [illegible]

December 13th, 1920 .... Flooded - water
February 20th, 1921 .... Pontoons
" 25th, " .... Moving pontoons.

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All shovels on rock surface while digging earth excavation used pontoons whether the excavation was exceptionally wet or only ordinarily so, in order to facilitate moving. It may be safely taken that No. 8 would have removed twice as much as No. 12 at the same cost, if the nature of the digging had been the same and the height lifted equal.

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Appendix 10. Sec. 3.

Cost Department,
July 12, 1923.

EFFICIENCY, COST & COMPARISONS OF SHOVELS

NO. 8 ELECTRIC & NO. 12 STEAM

TO - DECEMBER 31, 1921.

SHOVEL NO.		NO. SHIFTS WORKED.	QUANTITY EXCAVATED.	NO. CU. YDS. PER SHIFT.	SIZE OF DIPPER.	SHIFTS ON 1 CU. YD. DIPPER BASIS.	EFFICIENCY.	ACTUAL COST PER CUBIC YARD.
Shovel #8	Earth	909	1,876,422	2,064	8 Cu.Yd.	7,272	258	.98
	Rock	439	464,526	1,058	6 Cu.Yd.	2,634	177	4.24
Shovel #12	Earth	311	596,713	1,920	8 Cu.Yd.	2,488	239	1.56
	Rock	277	210,527	760	6 Cu.Yd.	1,662	127	5.08

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NOTE: In order to determine a <u>Common Comparative Figure called "Output Efficiency"</u> the actual shifts of each shovel are multiplied by the rated dipper capacity to bring it to the shifts required had the dipper been 1 cubic yard. Combining the output of #8 with its cost and comparing with #12 on the same basis there results what might be called "Cost" efficiency. In Earth #8 takes out 108.5 of #12 at a cost of 63% or an equivalent ratio of <u>170 to 100</u> and in Rock #8 takes out 139.2 of #12 at a cost of 83.5% or an equivalent ratio of <u>167 to 100</u> notwithstanding that #12 in both Earth and Rock was in shallow cuts.

A P P E N D I X 10. Sec. 4.

EFFICIENCIES STEAM VS ELECTRIC SHOVEL.
LARGE TYPE SHOVELS IN ROCK.

The ideal conditions under which these shovels can be equitably compared, obtain where the nature of the excavation is the same for all shovels; where train service is equal; where the depths of cuts or heights lifted are the same; where the shovels are all working at the same time of year, and where the shovels are the same age, or at the same stage of depreciation. The nearest approach to these conditions was during the period of July to November, inclusive in the year 1921, where the three electric 225-B shovels Nos. 1, 2 and 3 and steam shovels Marion 300 and 225-B, Nos. 11 and 12, were working south of Lundy's Lane in rock excavation. However, the heights lifted were not the same, the ages of shovels were not the same, and train service not equal, the advantages under these heads being almost wholly with the steam shovels.

The attached tabulation shows the average output per shift, the average depth of cut, and the monthly unit cost for each shovel for the period. This tabulation is quite self-explanatory, and it requires no further argument to prove the superiority of the electric shovels over the steam, as regards both production and economy, and in spite of the fact that the electrics were from two to three years old, and the steams brand new, and that the electrics were working in much deeper cuts and with more congested loading tracks, than the steam shovels.

No. 2 shovel was handicapped by digging out at station 150± and being

dismantled and re-assembled in October, digging in at station 100 and digging out at station 106 in November.

Comparing these shovels on the same basis of monthly output per shift, depth of cut, and cost per cubic yard, it will be seen that the electric shovels make a considerably better showing, particularly when the effect of the depth of cut is applied.

From a test of electric shovel No. 1 on May 28th, 1920, when digging in rock section of canal, with a depth of cut of 46 ft., the time of cycle was 53.2 seconds. The same shovel, while in a 30 ft. cut in rock section of canal on December 9th, 1920, gave a cycle time of 43 seconds. So that on the assumption that in the two depths of cut the total time of actual digging operations were the same, the output should be 24% greater for the shallow cut or at a ratio of 31 to 25, under equal train service and weather conditions, etc. In other words, the actual digging costs should be in ratio of 25 to 31.

Actually, the output for December 28th, 1920, day shift, when the test was taken, was 1,050 cubic yards car measure, which corrected to bank measurement was 785 cubic yards and on December 9th, day shift, the output was 730 cubic yards car measure, or 760 cubic yards bank measurement. However, for May 28th the delays were 1.155 hours, leaving 8,845 working hours, and on December 9th, 1920, 3.083 hours, leaving 6.917 working hours, so that for the same actual operating time the output on December 9th should be

$\frac{8845}{6917}$ x 760 c.y. = 932 cubic yards = 127% of May 28th, or 27% greater than on May 28th, 1920.

Comparing electric shovels Nos. 1 and 3 with steam shovel No. 11 where,

with the two former ones the depth of cut was 61 ft. as against 23.4 ft. for No. 11, it should be expected that, all other conditions being equal, No. 11 should have an output of at least 30 to 35% greater than either No. 1 or No. 8. Actually, it had an output per shift for this five months of only 77% of No. 1 and 82% of No. 8 while the averages of total monthly unit costs was 117% of No. 1 and 112% of No. 8. Furthermore, the records show that No. 11 had by December 1st, 1921 removed a total excavation of 1,260,000 cubic yards and No. 1 had removed 2,380,000 cubic yards and of the total for No. 11 only 201,800 cubic yards were rock and for No. 1 - 1,523,400 cubic yards. In other words, with a removal of over 7½ times the amount of rock excavation (which is the real criterion of depreciation) No. 1 shovel took out in the last five month period of work 30% more rock per shift and at an average monthly cost of 86% of No. 11. This is equivalent to 150% of No. 11 at the same cost, notwithstanding the severe depreciation of wear and tear from having taken out 7½ times the amount of rock excavation, and notwithstanding its working in a cut over 2½ times as deep. These relative efficiencies of electric vs steam shovels of 150 - 100 are determined by their performances during the best working period of the year in July to November, inclusive, and if the full year's record were the basis of comparison, this ratio, under ordinary conditions of construction, becomes at least 180 to 100. For, with a value of 150 for 12 months and 100 for 10 months (which period is a maximum for steam shovels) there results a ratio of 180 to 100. Over and above this, there should be applied the effect of depreciation, and if it had been possible to compare the two shovels under the same conditions of not only depreciation but depth of cut, time of season, labor

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efficiencies, etc., it would undoubtedly have resulted in a ratio of cost of close to 200 to 100 in favor of the electric shovel.

For, applying a conservative value of 25% of actual digging time gained had No. 1 been in shallow cut, the output of No. 1 would have been 125% of 130% of No. 11 or about 163%, which, at 86% of cost of No. 11 = 190% of No. 11. Adding the effect of depreciation, this easily becomes 200%.

This is corroborated by data prepared, dated October 26th, 1921 (copy attached) showing records of shovels Nos. 1, 2, 8, 11 and 12 in rock excavation to September 30th, 1921.

No. 1 electric shovel started rock excavation May 1919 and dug 29 months with an average man hour rate of 57.0¢ per hour.

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No. 2 electric shovel started rock excavation August 1919, and dug to September 30th, 1921 (less months of March to October 1920) at an average man hour rate of 57.8¢ per hour.

No. 8 electric shovel started rock excavation February 1921 and dug eight months at an average man hour rate of 61.6¢ per hour.

Mean equivalent of the three electric shovels = 55 months at 58¢.

No. 11 steam shovel started rock excavation July 1921 and dug three months at an average man hour rate of 59.4¢.

No. 12 started rock excavation in May 1919 and dug five months at an average man hour rate of 60.7¢ per hour.

Mean equivalent of Nos. 11 and 12 = 8 months at 60.2¢.

Total rock removed by Nos. 1, 2 and 8 = 2,673,823 cubic yards in 2,063 shifts = <u>1,027</u> cubic yards per shift of ten hours.

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Total rock removed by Nos. 11 and 12 = 242,689 cubic yards in 324 shifts = 749 cubic yards per shift of ten hours.

The unit price of electric shovels is \$3.55 per cubic yard and the unit price of steam shovel is \$4.75 per cubic yard.

The electric shovel removed 137.2% of steam per shift and at a cost of 75% of steam, or the equivalent of 183% of steam at the same cost. These shovels also worked all the year round while the steam worked the summer months, and in addition the comparative depths of cut for the electric and steam shovels were as follows:

No. 1 -	1,465,437	cubic	yards	at 50'	cut
" 2 -	615,874	"	"	" 46'	"
" 6 -	592,512	"	"	" 51'	"
	2,673,823	"	"	" 50.4'	"

For steam:

No. 11 -	106,557	cubic	yards	at 23.4'	cut
" 12 -	136,132	"	"	" 61'	"
	242,689	"	"	" 44.4'	"

From previous tests, it was established that a ratio of cut or lift of 28 to 46 made a difference of 24% in the output, or 100 to 167 gives an increase of 24% in output. On the same basis 44.4 to 50.4 should give 16% greater output for the shallow cut - $\frac{183\% \times 116}{100}$ = final cost - 212%. Modifying this for an equivalent man hour rate, it becomes $\frac{580}{602} \times 212 = 204\%$. In other words, for equivalent cost, the electric shovels on the Niagara work produced 204% of the steam shovels.

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Appendix 10 ..... 6.

The following is quoted from the Bucyrus catalogue 19-A, page 11:

"It may be said, however, that their greater high cost is more than compensated by their more economical operation, saving in track shifting, etc. To quote one instance; a large mining company originally loaded ore with standard railroad type steam shovels at a cost of 21 cents per ton. They installed electric shovels of the same type and reduced this cost to 7 cents a ton. They now are loading the same material with a 225-B Bucyrus electric shovel at a cost of 3 cents a ton."

The catalogue from which this is quoted was issued in May 1920 and would therefore refer to conditions analagous at least as to time and kind of equipment, to the Niagara job. The prices quoted most emphatically corroborate the results obtaining on the Hydro work at Niagara; namely, that the electric shovels are conservatively twice as efficient as steam and that the 225-B type is more efficient than the railroad type, whether both are operated by steam or electric power.

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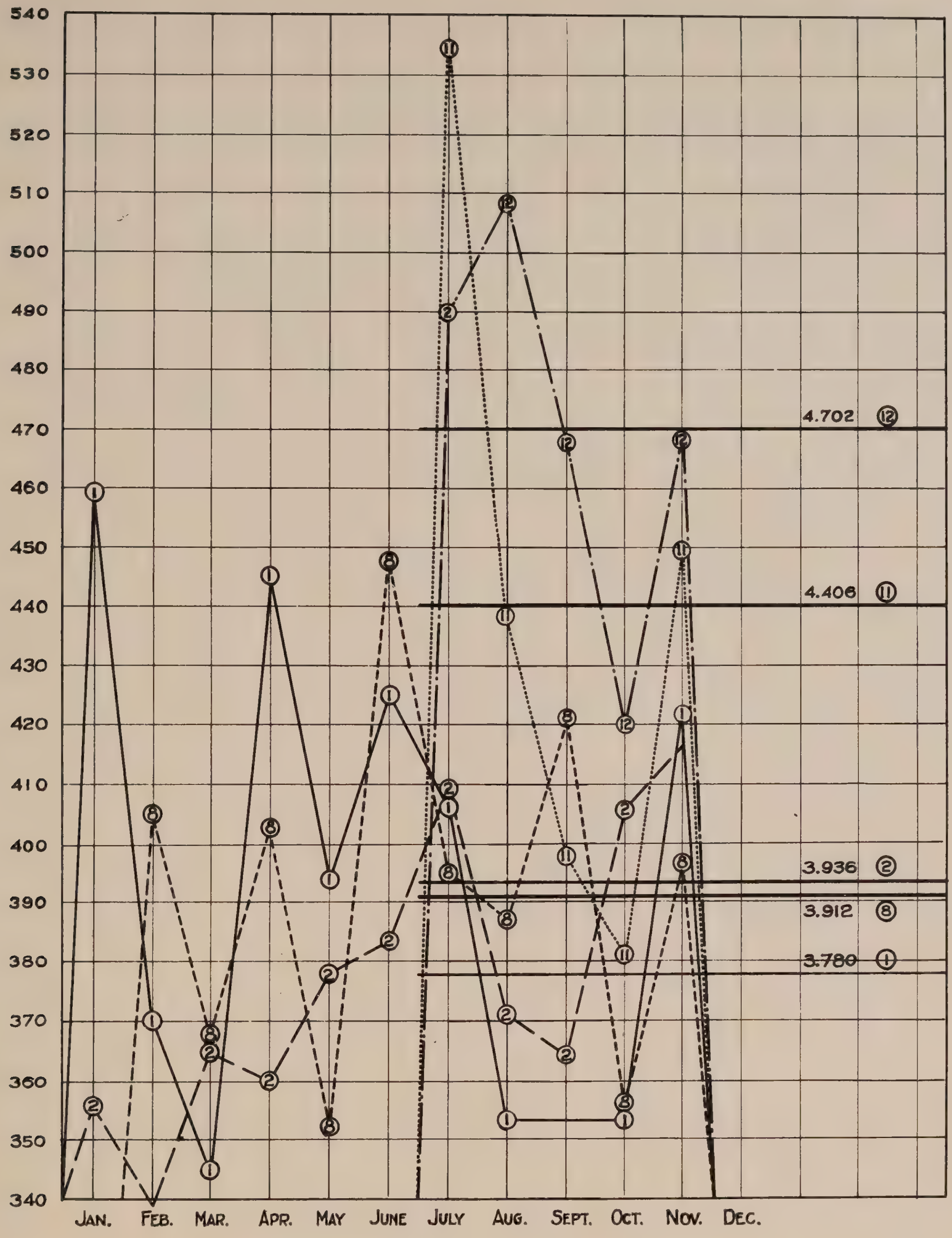
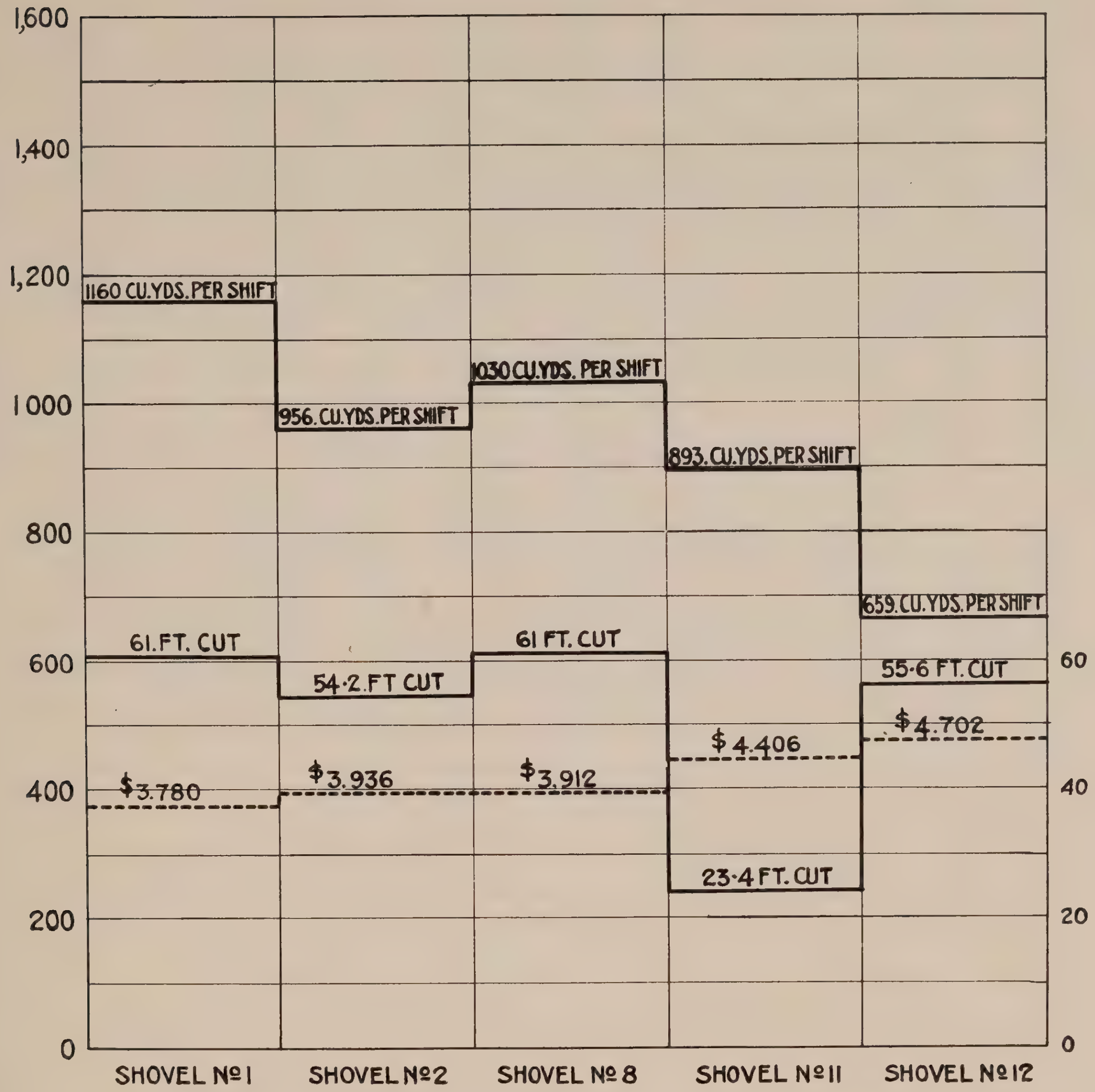


APPENDIX 10–CHART A

MONTHLY UNITCOSTS SHOVELS 1,2,8,11 AND 12 JULY TO NOVEMBER 1921

June, 1923

Re-drawn by Walter J. Francis & Company, Consulting Engineers, August, 1923.



APPENDIX 10 – CHART B

OUTPUT PER SHIFT, HEIGHT OF LIFT AND MONTHLY UNIT COSTS FOR SHOVELS 1, 2, 8, 11, AND 12 FOR JULY, AUG, SEPT, OCT, AND NOV, 1921

June, 1923.

Re-drawn by Walter J. Francis & Company
Consulting Engineers, August, 1923.

A P P E N D I X 10. Sec. 4.

MONTH 1921	ELEC. SHOVEL NO. 1 AMOUNT PER SHIFT CU. YDS.	DEPTH OF CUT FEET	UNIT COOST $	ELEC. SHOVEL NO. 2 AMOUNT PER SHIFT CU. YDS.	DEPTH OF CUT FEET	UNIT COST $	ELEC. SHOVEL NO. 8 AMOUNT PER SHIFT CU. YDS.	DEPTH OF CUT FEET	UNIT COST $
July	1,100	61	4.06	1,060	46	4.10	1,160	61	3.95
Aug.	1,170	61	3.53	950	61	3.71	1,060	61	3.87
Sept.	960	61	3.53	930	61	3.64	870	61	4.21
Oct.	1,030	61	3.53	1,200	61	4.06	925	61	3.56
Nov.	1,540	61	4.22	740	42	4.17	1,115	61	3.97
AVERAGE	1,160	61	3.78	956	54.2	3.936	1,030	61	3.91

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MONTH 1921	STEAM SHOVEL NO. 11 AMOUNT PER SHIFT CU. YDS.	DEPTH OF CUT FEET	UNIT COST $	STEAM SHOVEL NO. 12 AMOUNT PER SHIFT CU. YDS.	DEPTH OF CUT FEET	UNIT COST $
July	575	16	5.35	710	42	4.85
Aug.	860	22	4.39	800	52	5.09
Sept.	995	28	3.98	570	60	4.68
Oct.	1,075	25	3.81	545	60	4.20
Nov.	960	26	4.50	670	60	4.69
AVERAGE	893	23.4	4.406	659	55.6	4.702

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Appendix 10. October 26th, 1921.

	LABOR AND MATERIAL, EXCAVATION, LOADING.	LABOR AND MATERIAL EXCAVATION, LOADING, DRILLING AND BLASTING	TOTAL PER YARD
Cost per yard of rock excavation - 225-B electric shovel	$ .72	$ 2.06	$ 3.55
Cost per yard of rock excavation - 225-B steam shovel	1.12	2.53	4.75

Average power for 225-B electric shovels .... 370 HP

" energy " " " " per cubic yard production .... 1.35 KW hours

Cost of power per yard for 225-B electric shovels - rock ... .51¢

" " energy " " " " - earth .. .273¢

Peak load for 225-B shovels .... 795 HP

Pounds of coal per yard - 225-B steam shovels .... 27.7 lbs.

Rates paid shovel operators (runner) .... .87¢ (11 hours)

(cranesmen) .... .68¢ (11 hours)

225-B steam shovel uses 450 tons of coal per month (2 shifts)

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APPENDIX 11.

CONDITIONS INFLUENCING THE LOWER OUTPUT OF SHOVELS, RESULTING IN INCREASED COSTS AND DELAYS.

Reported actual shovel records, and the observed performance of the newer type of revolving shovels at other points, appeared to be the best possible evidence that, with conditions equal, the Commission could well depend upon equal or better shovel performance on the work at Niagara, on account of having the advantage of cheap electric power and an unsurpassed dumping ground of over 200 acres, with an average depth of 65 feet.

The borings made at about [illegible] feet intervals, over the line of canal, gave no evidence that unstable ground would be encountered, and while showing fine sand underlying the top strata and overlying gravel and hardpan next the rock, there was no evidence of flow of water under pressure originating from the rock as ultimately developed. Neither did it appear that there was any flow of water from the fine sand which later proved quicksand. Water was encountered in the borings when rock was reached, but it could quite naturally be assumed that it was of the usual ground surface origin and would readily drain into the shovel cut when opened to the rock. However, after the overburden was removed, it was found, that, while water continued to flow through the gravel and sand strata, reducing the ground water level in the adjacent districts, heavy flows of water were also encountered at frequent intervals originating under pressure from rock fissures. This latter condition was the prime cause of wet excavation which ultimately had so serious an effect in the

output of the shovels, and the delays in the disposal. The frequency of these springs kept the ground impregnated with water at or near the surface of the rock causing serious and frequent slides into the shovel cut as it was opened, and expensive trouble and delays in the operation and the disposal of the spoil. Under normal conditions it is expected that shovel cuts in earth would have water present, but in practically all cases, it originates from the surface and readily drains away when relief is provided by the excavated cut. On the contrary, the springs encountered in the cut at Niagara, appeared to flow at undiminished rates, in consequence of which there was no relief by drainage. This abnormal condition was evidenced by the large volumes of water that were being pumped from the canal section as late as the summer of 1920, long after the shovels had passed in the earth excavation. This condition was, therefore, primarily, the cause of not only greatly reducing the output of the large shovels, but of seriously affecting its disposal.

The train of evils resulting from the wet excavation may be enumerated in general as follows:

(1) - The loading of cars was restricted on account of the slopping over. Of course, if it were physically possible to place dipper loads exactly in their proper centre positions in the cars, the settlement would be even, and at most 20 cubic yards could be given each car, but it is quite evident that in practice this is out of the question and the results were that throughout the entire work of all earth excavation, the <u>average</u> carload in wet and dry excavation was 17 to 18 cubic yards for a 20 cubic yard car.

(2) - Delays at the dump due to wet material sticking in the cars, and

frequently having to be shovelled out.

(3) - The sliding of the dump itself, often taking track and cars with it. This often reduced the number of available dumping points, causing trains to wait for space at the dump.

(4) - Immediately following the excavation by shovel, it became necessary to dump train loads of rock from the loading track to hold up the sides of the cut, not only to prevent the sides from going into the cut, but to support the loading track as well. While this was being done, the shovel, of course, could not load.

(5) - The frequent moving back of the shovel to avoid having the base buried by mud from the sides and face of the cut. This condition necessitated tedious delays in the cleaning up of the bottom and replacing of track. Frequently, rip-rap had to be re-handled and placed on the face of the cut immediately ahead of the shovel, particularly during comparatively short shut-downs between shifts or over Sunday.

(6) - The difficulties of keeping men in cuts of this kind, particularly when labor was so inefficient and independent. This resulted in the necessity of continuously training new men for this work.

(7) - As an instance of the inefficiency of labor - under ordinary conditions of shovel work, four men should be sufficient for doing the work of moving a 225-B shovel ahead, particularly in earth excavation, as this shovel was equipped to move its own track and pontoons, and the cut being ordinarily so deep that the number of moves would seldom exceed six per day, and was more often three to four. During the period when the work was in progress, the

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ordinary crew in front of a shovel was eight men, and on more than one occasion the crew refused to work when even one of their number was missing.

(3) - The congestion which finally resulted in the south end of the work in the spring of 1921, with six shovels operating within a distance of two miles, and all loading on one side of the canal.

Another source of delay, while not connected with wet excavation, was the protracted series of negotiations covering particularly the agreement and plans for the combined bridge of the Grand Trunk and Michigan Central (Niagara Division).

This matter had been before the railway companies as early as December, 1916, yet upon the delivery of No. 2 shovel in January, 1918, it was quite evident that it would be impossible for this shovel to pass through the finished structure at the time scheduled; namely, May or June, 1918. It was therefore decided to erect the shovel on the south side of the bridge. To keep this unit working it was necessary to work in railway excavation and dispose of the output in small depressions in the Whirlpool yard location. This resulted in reduced yardage and actual delay in taking out canal excavation for which the shovel was purchased. The final excavation of earth under the arch bridge was not completed until June, 1919, and the rock not until August, 1921.

Even No. 1 shovel, which had completed the greater percentage of earth and rock excavation north of the bridge by January, 1921, had to be dismantled and re-assembled in its new location south of the bridge, on account of not having right-of-way underneath.

When it was decided to start No. 2 south of the bridge, the gravity of

Appendix 11 ..... 5.

the delay on the bridge negotiations had not developed to serious proportions, except that it was necessary to provide passage for trains serving the shovels working north of the bridge, which had to dispose of part of this output at other points than those provided north of the bridge. This was on account of the yardage being increased beyond the original project, in which it was contemplated to dispose of all of it north of the bridge location.

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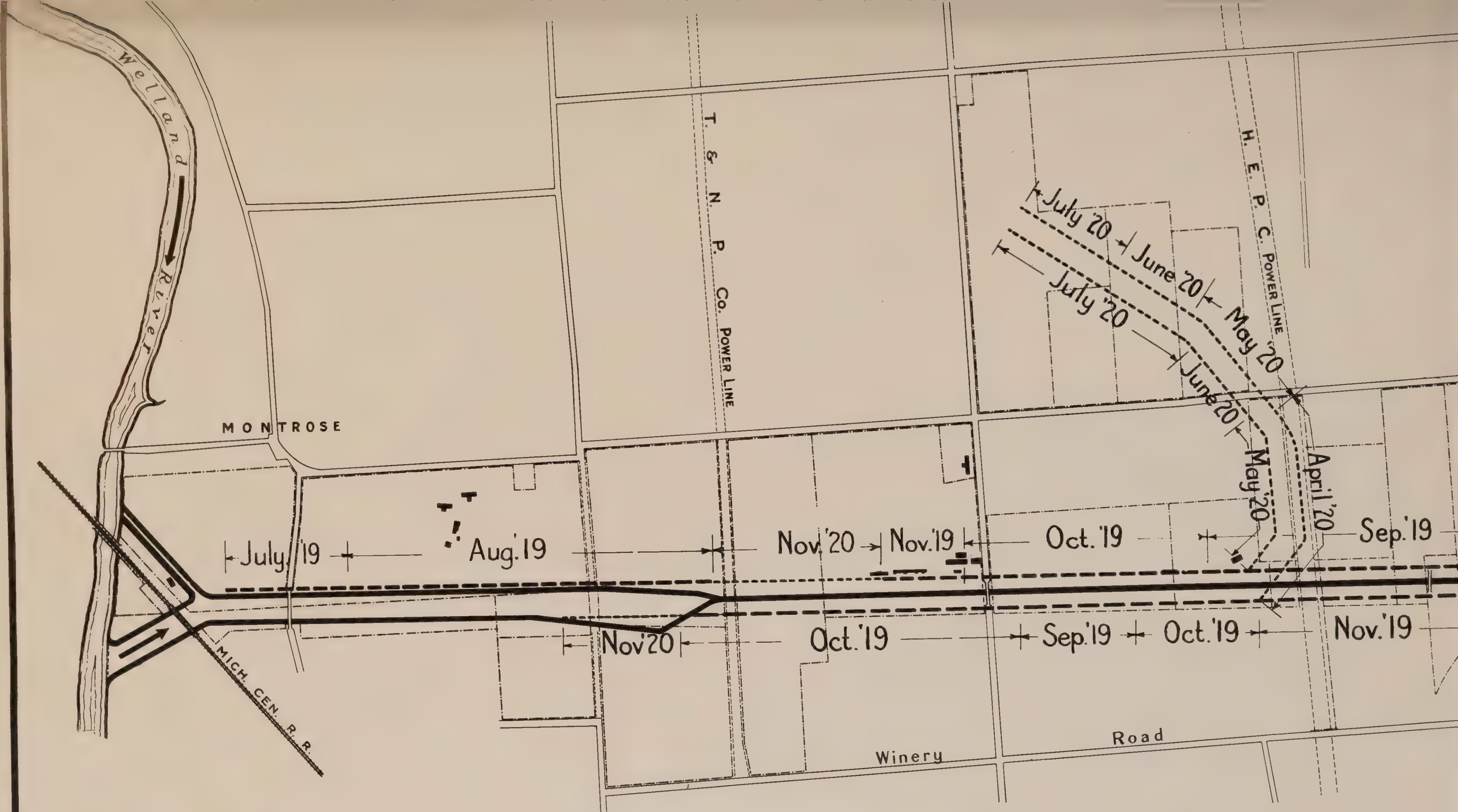
Re-drawn by Walter J. Francis & Company, Consulting Engineers, August 1923.

APPENDIX 12

PLAN SHOWING COMPLETION OF TRACK LAYING, DOUBLE TRACK MAIN LINE CONSTRUCTION RAILWAY

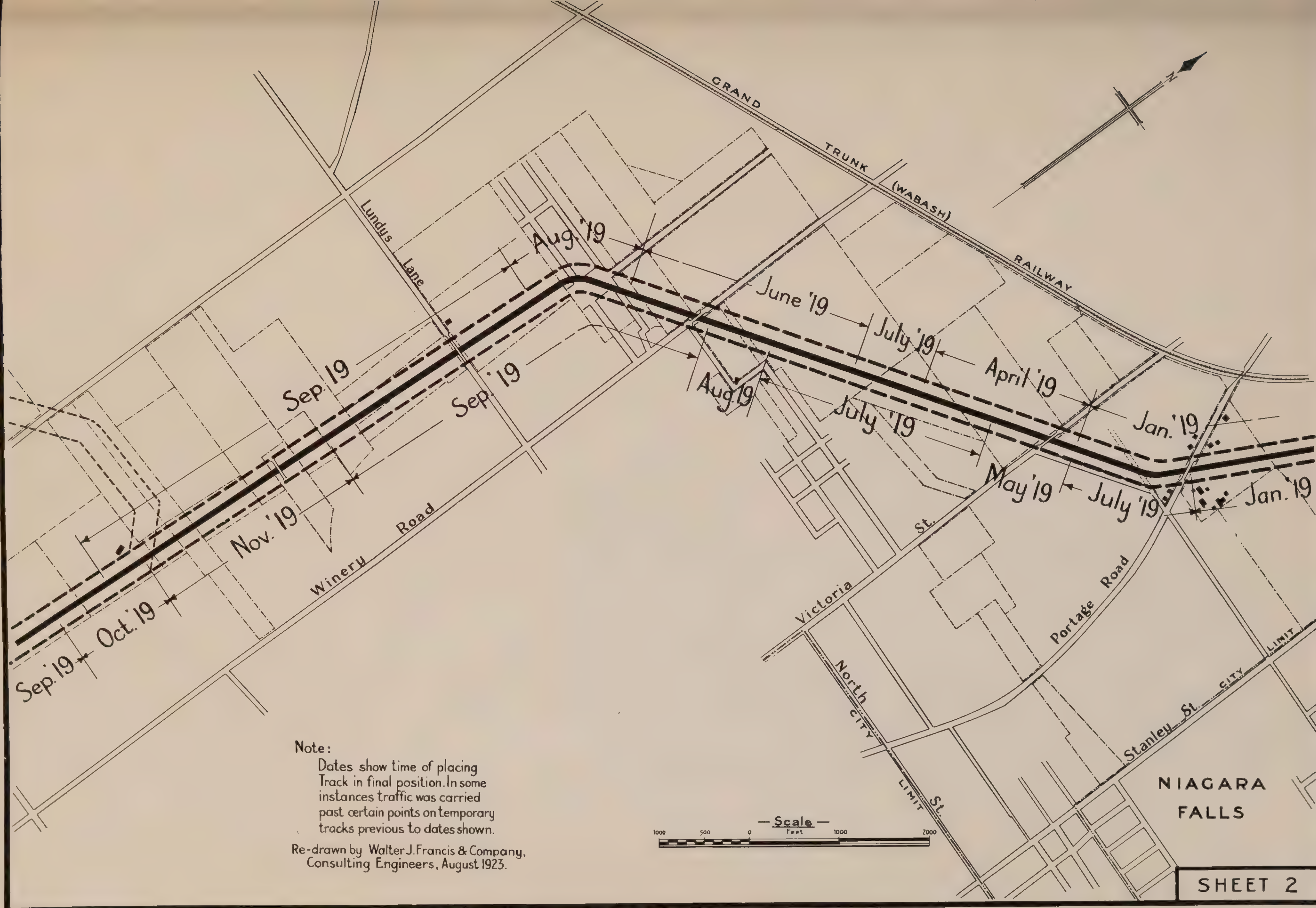
KEY PLAN FOR 5 SHEETS FOLLOWING



Note:
Dates show time of placing Track in final position. In some instances traffic was carried past certain points on temporary tracks previous to dates shown.

Re-drawn by Walter J. Francis & Company, Consulting Engineers, August 1923.

SHEET 1


GRAND TRUNK (WABASH) RAILWAY
N
Lundys Lane
Winery Road
Victoria St.
Portage Road
North CITY LIMIT St.
Stanley St. CITY LIMIT
NIAGARA FALLS
Aug. '19
June '19
July '19
April '19
Jan. '19
Aug. '19
July '19
May '19
July '19
Jan. '19
Sep. 19
Sep. '19
Nov. '19
Oct. '19
Sep. '19
— Scale —
Feet
1000
500
0
1000
2000
Note:
Dates show time of placing Track in final position. In some instances traffic was carried past certain points on temporary tracks previous to dates shown.
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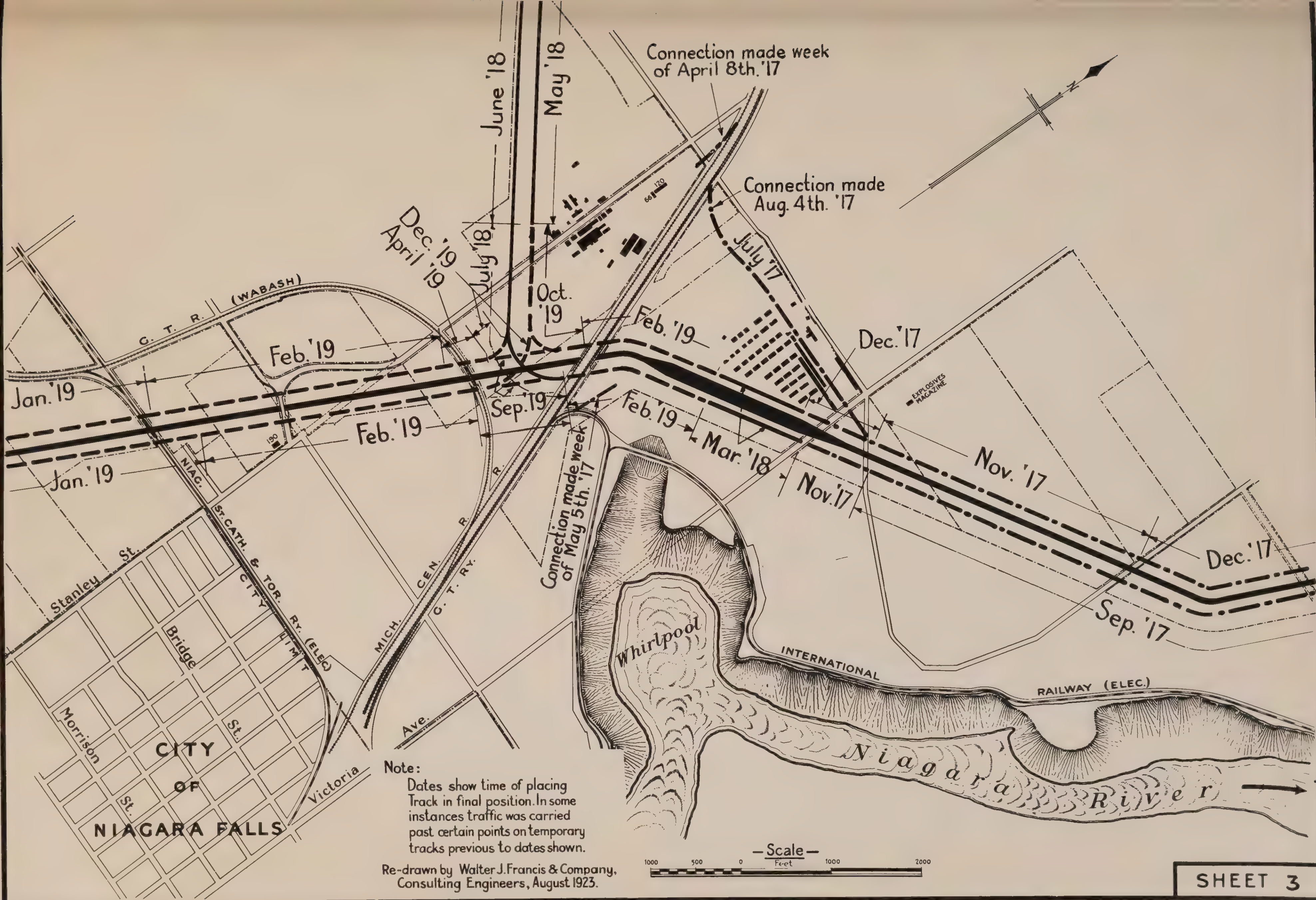
SHEET 2



Note:
Dates show time of placing Track in final position. In some instances traffic was carried past certain points on temporary tracks previous to dates shown.

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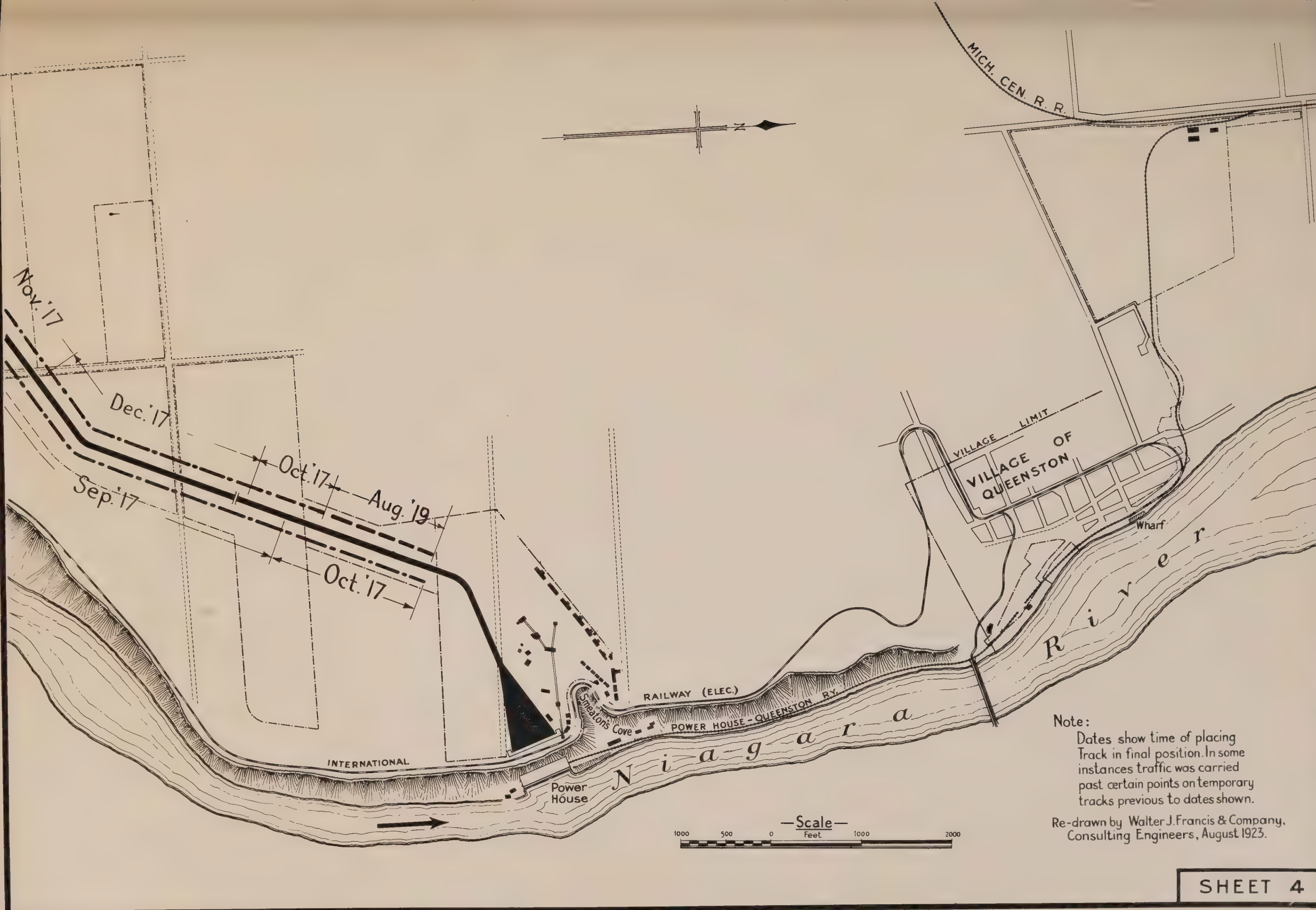

Note:
Dates show time of placing Track in final position. In some instances traffic was carried past certain points on temporary tracks previous to dates shown.

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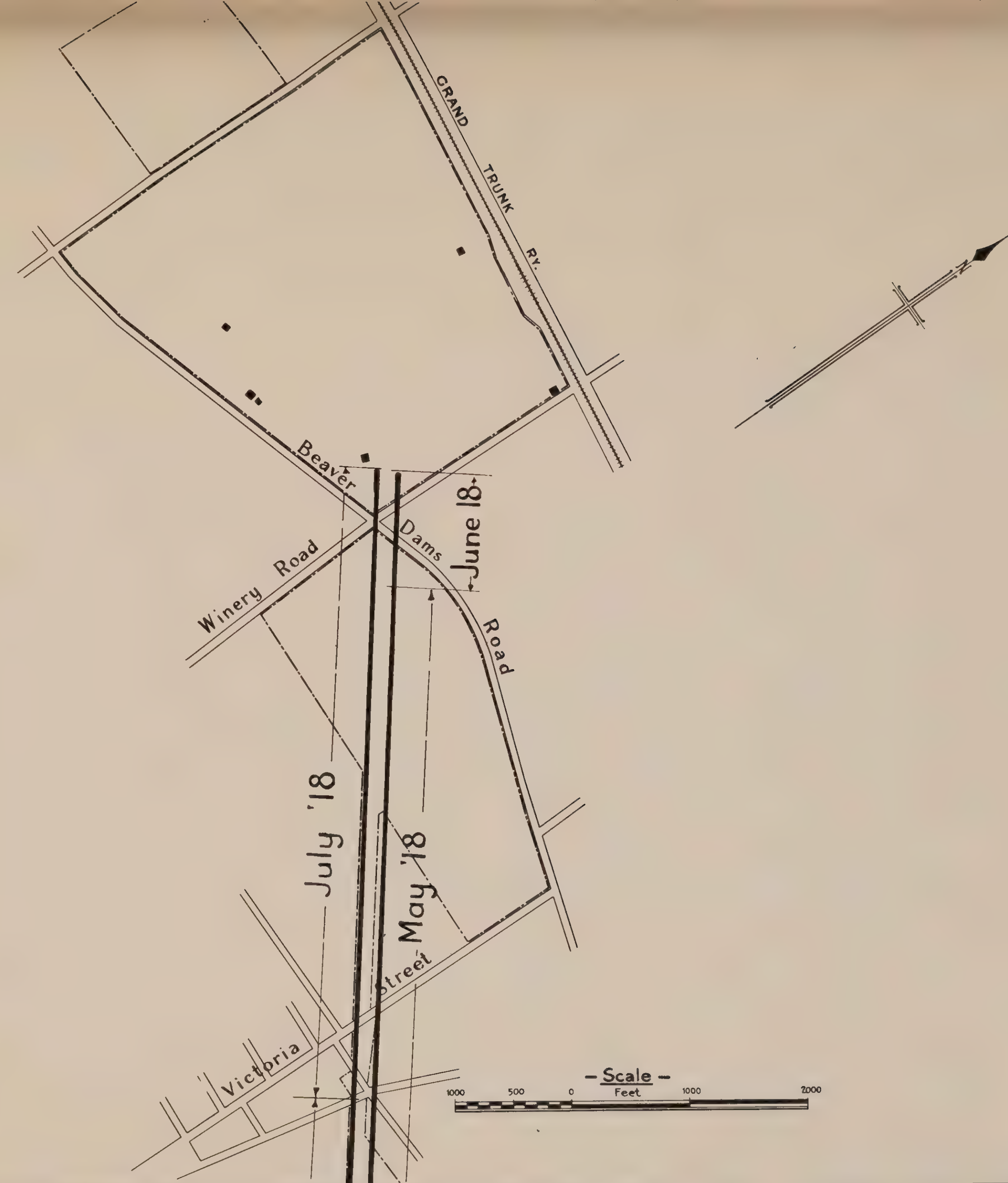
SHEET 4



Note:
Dates show time of placing Track in final position. In some instances traffic was carried past certain points on temporary tracks previous to dates shown.

Re-drawn by Walter J. Francis & Company, Consulting Engineers, August 1923.

SHEET 5

A P P E N D I X 13.

COST OF ROCK AND EARTH EXCAVATION, CONCRETE FOR LINING AND RETAINING WALLS, AND RIP-RAP FOR CANAL, FOREBAY AND SCREEN-HOUSE (EXCLUSIVE OF REINFORCED CONCRETE IN SCREEN-HOUSE) ACCORDING TO PRICES TENDERED FOR 11 SECTIONS OF THE CALUMET-SAG CANAL NEAR CHICAGO, AND THE CONTRACT PRICES AND ACTUAL COST OF THE ROCK EXCAVATION FOR THE LIVINGSTONE CHANNEL IN THE DETROIT RIVER.

These works were prosecuted during the years 1910 to 1916.

The Calumet-Sag prices will be discussed under three headings:

(1) - By using the lowest price bid in each of the 11 sections for each specified item, irrespective of whether this price is in the lowest complete tender bid or not.

(2) - By using the average of all the prices tendered on the same 11 sections for specified items.

(3) - By using the price appearing for each specified item in the accepted tender for each section.

The 11 contracts of the Calumet-Sag canal work consisted of 7,856,000 cubic yards of glacial drift or earth excavation; 1,723,000 cubic yards of rock excavation; 965,300 square feet of channeling; 348,500 square yards of rip-rap; 31,075 cubic yards of No. 1 concrete; 30,950 cubic yards of No. 2 concrete; 14,795 lin. ft. of roadways; and miscellaneous items including bridges, etc.

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APPENDIX 19.

COST OF ROCK AND EARTH EXCAVATION, CONCRETE FOR [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

These works were prosecuted during the years 1910 to 1916.

The Welland-Ship prices will be discussed under three headings:

COPY

(1) - By using the lowest price bid in each of the 11 sections for each specified item, irrespective of whether this price is in the lowest complete tender bid or not.

(2) - By using the average of all the prices tendered in the above 11 sections for specified items.

(3) - By using the prices appearing for each specified item in the accepted tender for each section.

The 11 contracts of the Welland-Ship Canal were advertised at [illegible] cubic yards of glacial drift or earth excavation; [illegible] cubic yards of rock excavation; [illegible] square feet of channelling; [illegible] square yards of rip-rap; [illegible] cubic yards of No. 1 concrete; [illegible] cubic yards of No. 2 concrete; [illegible] lin. ft. of [illegible]; and miscellaneous items including bridges, etc.

Appendix 13 ..... 2.

The following table shows the quantities of the various main items for each section, with the dates on which the bids were opened. Contracts Nos. 6 and 13 are not included, the data for the same not being available.

SECTION	BIDS OPENED	C.Y. GLACIAL DRIFT	C.Y. ROCK	SQ. FT. CHANNELING	SQ. YDS. RIP-RAP	C.Y. NO. 1 CONCRETE
1	Jul. 25/14	520,000	315,000	270,000	500	10,050
2	Oct. 5/11	221,000	351,000	213,000	-	3,200
3	Feb. 15/12	335,000	220,000	182,300	5,000	13,400
4	Aug. 10/11	780,000	121,000	-	37,000	-
5	May 31/12	1,070,000	141,000	-	69,000	375
7 & 8	Jul. 19/13	2,550,000	15,000	-	-	1,200
9	Sep. 11/13	875,000	50,000	-	70,000	1,100
10	Apr. 15/13	670,000	[illegible]	-	72,000	800
11	Mar. 12/14	750,000	[illegible]	-	70,000	-
12	May 21/14	485,000	126,000	100,000	25,000	950
		7,856,000	1,723,000	965,300	348,500	31,075

The depths of cuts were favorable for the operation of the largest and most modern types of excavating machinery which were in actual operation when the work was visited. (See Appendix 1 of Mr. Goodwin's report on Excavation Methods.)

The total excavation of 9,579,000 cubic yards of material in the 11 sections which added to Sections Nos. 6 and 13 (not available at the time) compares more closely than any other contemporary work, with the excavation of 14,420,000 cubic yards of material on the Queenston-Chippawa Development.

Not only was there similarity in magnitude, but the nature of the excavation and the conditions under which the work was done, appeared to correspond very closely to what the data, at that time, indicated for the Queenston-Chippawa

COPY

Appendix 13 ..... 3.

work.

There were 34 bidders on these 11 sections. The bids were tendered between the years 1911 and 1915 and the work was still in progress in 1916.

The average prices for rock excavation for the 11 sections forcibly illustrate the influence that large quantities have on prices tendered. This is shown on the curve attached hereto, and indicates the relationship between quantities involved and prices bid. This curve shows that, with all other conditions similar, the prices tendered for large yardages are in a marked degree less than where the quantities are small. This fact indicates the justification for considering the item of magnitude in assigning a unit price for the excavation of the 4,357,435 cubic yards of rock involved in the Queenston-Chippawa work under one construction administration, as against 1,723,000 cubic yards of rock under eleven separate and distinct organizations on the Calumet-Sag.

It may, therefore, be reasonably concluded that the prices obtaining on these various contracts were greater than would obtain under otherwise similar conditions for the Queenston-Chippawa excavation work.

The work of rock excavation for the Livingstone Channel in the Detroit River was done for the United States Government.

The original plan was to cut a 300 ft. channel 4,100 ft. long, to a depth which would provide 23 ft. of water. It was subsequently lengthened to 5,600 ft. and widened to 450 ft.

The 1,500 ft., which was lengthened northwards, was originally a dredge contract, but was sub-let to Grant-Smith and Company, who had the main channel

Appendix 13 ..... 4.

work. The sides of the cut were channeled, but after the work was under way it was decided to widen an additional 150 ft., which obviated the necessity of any further channeling on the west side of the original 300 ft. channel, so that only about one-third of this side was channeled.

The original contract price was $1.24 per cubic yard which <u>included</u> channeling and $75,000.00 of <u>cofferdam work</u>, an additional $25,000.00 being also spent on the cofferdam by the United States Government. This price ($1.24) covered a channel 5,600 ft. long and 300 ft. wide. The price for widening was $1.10 per cubic yard, the original cofferdam being sufficient for both widths.

The work was started in 1908 and completed in 1911.

The material encountered was limestone, very similar in formation to that at Niagara Falls. It was removed by three steam shovels, <u>loading into skips</u>, which were handled by three travelling cableways. The excavated material was dumped along the cut 50 ft. back from the channel sides. The work is said to have cost about 85 cents per cubic yard, <u>including all charges</u>.

The following is the distribution of the cost:

Cofferdam and removal (ends removed only)	8.7%
Pumping	10.0%
Channeling, including air, ...	3.0%
Drilling, " "	15.2%
Blasting	17.5%
Excavation, including depreciation, etc.	22.6%
Conveying and disposal of material	16.5%
General expenses	6.5%
	100 %

Assuming 85 cents per cubic yard as the total cost, and deducting 10% as a charge for cofferdam and pumping, the cost of excavation under similar conditions

Appendix 13 ..... 5.

to the Queenston-Chippawa canal and forebay, would be about 72 cents per cubic yard.

The original contract for the 1,500 ft. at the north end was to provide for a depth of 22 ft., but after it was sub-let to the contractor, Grant-Smith and Company, it was decided to increase the depth to 23 ft.

The total excavation in the final enlarged area (5600' x 450') was 1,227,777 cubic yards of rock. The price in the original contract was $1.24 per cubic yard. The resulting price of the enlarged section, including cofferdam, pumping, channeling, etc., was $1.14 per cubic yard. Exclusive of the cofferdam ($75,000.00) this unit price becomes $1.08 per cubic yard. In view of the restricted space and the consequent expensive and slow methods of handling the excavated material, it is reasonable to assume that with large shovels and direct disposal facilities, the price of $1.08 should be reduced by 10 to 15%. Furthermore, leaving aside this feature, if the price of $1.08 were reduced by a contractor's profit of 25%, it would become about 86 cents per cubic yard. As a matter of fact, the United States Government engineers' records of actual labor and material costs entering into the work, led them to believe that the actual cost was about 85 cents per cubic yard including unwatering costs. If the cofferdam were deducted this unit cost would become 79 cents per cubic yard, which includes pumping, channeling, etc.

Comparing this with the Niagara work and assuming that the pumping should be included, the price of 79 cents would be reduced (15%) to less than 70 cents per cubic yard when taken out by cars and locomotives instead of skips and cableways.

to the Cornwall-Chippewa canal and dredging, would be about 75 cents per cubic yard.

The original contract for the 1,000 ft. of the north end was to provide for a depth of 25 ft., but after it was awarded to the contractor, Dredge-Smith and Company, it was decided to increase the depth to 30 ft.

The total excavation in the final enlarged area ([illegible]) was [illegible] cubic yards of rock. The price in the original contract was $1.51 per cubic yard. The resulting price of the enlarged section, including cofferdams, pumping, unwatering, etc., was $1.15 per cubic yard. Exclusive of the cofferdam ([illegible]) this unit price became $1.08 per cubic yard. In view of the restricted space and the expensive and slow methods of handling the excavated material, it is reasonable to assume that with large shovels and direct disposal facilities, the price of $1.08 could be reduced by [illegible]. Furthermore, leaving out [illegible] features, if the price of $1.08 were reduced by a contractor's profit of 15%, it would become about [illegible] cents per cubic yard. As a matter of fact, the United States Government engineers' analysis of actual labor and material costs entering into the work, led them to believe that the actual cost was about 67 cents per cubic yard including contractor's profit. If the cofferdams were deducted this unit cost would become 62 cents per cubic yard, which included pumping, unwatering, etc.

Comparing this with the figures here and assuming that the pumping should be included, the price of 75 cents would be reduced ([illegible]) to less than 57 cents per cubic yard when [illegible] by [illegible] and [illegible] instead of [illegible] and [illegible].

Appendix 13 ..... 6.

Consideration should also be given here to the effect that large quantities have on unit cost; namely, 1,227,777 cubic yards in the Livingstone Channel as against 4,357,438 cubic yards at Niagara.

These two jobs, the Calumet-Sag Canal and the Livingstone Channel, constituted the only two contemporary pieces of work on the continent which approached anywhere near the Queenston-Chippawa Development in magnitude, or were in any way analogous as regards the nature of the work and the working conditions.

In the following tables, I, II, III and IV, the unit prices for earth, rock, concrete and rip-rap on the Calumet-Sag Canal have been tabulated under the three main headings specified on page 1 hereof, and these tables have been further summarized in tables V, VI, and VII attached.

These three latter tables show the general averages for the unit contract prices on 11 sections of the Calumet-Sag Canal for earth, rock, concrete and rip-rap as follows:

CLASS OF WORK	LOWEST PRICE BID	AVERAGE OF ALL BIDS	ACCEPTED TENDER
Earth	$0.309	$0.379	$0.326
Rock - channeled	0.865	0.904	0.875
" unchanneled	0.674	0.778	0.706
Plain concrete	5.85	7.13	6.66
Rip-rap	0.974	1.452	1.136

As previously mentioned, the corresponding contract price for rock in the Livingstone Channel, without cofferdam, and allowing for more efficient and rapid excavation methods, is 92 cents per cubic yard.

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A comparison of these various contract prices with the 1917 unit prices used in the Queenston-Chippawa estimates, is worked out hereunder:

ROCK - CHANNELED:

CALUMET-SAG:		QUEENSTON-CHIPPAWA	EXCESS IN %
Average of lowest bids	.865	1.215	40.5
" " all "	.904	1.215	34.4
" " accepted bids	.875	1.215	39.0
Livingstone Channel	.920	1.215	32.0

ROCK - UNCHANNELED:

CALUMET-SAG:			
Average of lowest bids	.674	.95	41.0
" " all "	.778	.95	22.0
" " accepted bids	.706	.95	34.5

EARTH:

CALUMET-SAG:			
Average of lowest bids	.309	.337	9.0
" " all "	.379	.337	11.0 (less)
" " accepted bids	.326	.337	3.5

PLAIN CONCRETE:

CALUMET-SAG:			
Average of lowest bids	5.83	11.04	89.0
" " all "	7.13	11.04	55.0
" " accepted bids	6.66	11.04	66.0

RIP-RAP:

CALUMET-SAG:			
Average of lowest bids	.974	1.875	92.5
" " all "	1.452	1.875	29.0
" " accepted bids	1.136	1.875	65.0

Appendix 13 ...... 8.

It will be seen that the percentages of excess estimated cost are the least in the case of earth. This is entirely consistent, as the use of electric power in place of steam would have the greatest economic effect where the yardage was greatest and where there were no special cost factors, such as channeling, drilling, blasting, etc., as in the case of rock, or where material costs were an essential factor, as in the case of concrete.

These comparative figures tend to further confirm the judgment of the Commission's engineers, and the engineers and contractors who advised them in 1916 and 1917.

In making the above comparisons, it has been assumed that the adding of the 25% contingency item to the net estimated bare costs in the 1917 estimates for the Queenston work would place them on a fair comparative basis with the corresponding contract prices on the Calumet-Sag and the Livingstone. As a matter of fact, it would be quite reasonable to assume that these contract prices carry a burden of 10% for contingencies and 25% for profit, over bare net cost. Such being the case, the net unit prices for Queenston might reasonably have been increased by 35% instead of 25% in order to make them fairly comparable with the contract prices above mentioned. If this had been done the 1917 unit prices for Queenston would have been 30% to 50% in excess of the contract figures for rock and correspondingly increased in the case of earth and plain concrete.

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Appendix 15 ..... 9. TABLE I.

EARTH EXCAVATION - CALUMET-SAG.

COPY

SECTION	CUBIC YARDS	BIDDER	UNIT PRICE
1	265,000	Lowest	.24
		Average	.329
		Accepted	.248
	55,000	Lowest	.30
		Average	.425
		Accepted	.35
2	221,000	Lowest	.19
		Average	.264
		Accepted	.22
3	335,000	Lowest	.27
		Average	.29
		Accepted	.29
4	780,000	Lowest	.24
		Average	.291
		Accepted	.25
5	1,070,000	Lowest	.24
		Average	.26
		Accepted	.24
7 and 8	2,350,000	Lowest	.425
		Average	.499
		Accepted	.425
9	875,000	Lowest	.285
		Average	.42
		Accepted	.2375
10	670,000	Lowest	.31
		Average	.395
		Accepted	.326
11	750,000	Lowest	.27
		Average	.355
		Accepted	.292
12	485,000	Lowest	.235
		Average	.282
		Accepted	.255

Appendix 13 ..... 10. TABLE II.

ROCK EXCAVATION - CALUMET-SAG.

SECTION	EXCAVATION AND CHANNELING	BIDDER	UNIT PRICE CHANNELING	NO CHANNELING
1	31,500 c.y.	Low	.89	.65
	270,000 sq. ft.	Average	1.05	.77
		Accepted	.89	.65
2	351,000 c.y.	Low	.83	.65
	313,000 sq. ft.	Average	.99	.75
		Accepted	.83	.65
3	220,000 c.y.	Low	.90	.69
	132,300 sq. ft.	Average	.95	.74
		Accepted	.90	.69
4	121,000 c.y.	Low	-	.70
		Average	-	.79
		Accepted	-	.77
5	141,000 c.y.	Low	-	.70
		Average	-	.72
		Accepted	-	.70
7 and 8	15,000 c.y.	Low	-	.90
		Average	-	2.15
		Accepted	-	1.90
9	50,000 c.y.	Low	-	1.15
		Average	-	1.27
		Accepted	-	1.25
10	300,000 c.y.	Low	-	.62
		Average	-	.68
		Accepted	-	.69
11	85,000 c.y.	Low	-	.65
		Average	-	.93
		Accepted	-	.65
12	125,000 c.y.	Low	.85	.65
	100,000 sq. ft.	Average	.97	.73
		Accepted	.93	.70

Appendix 13 ..... 11. TABLE III.

PLAIN CONCRETE - CALUMET-SAG.

SECTION	CUBIC YARDS	BIDDER	UNIT PRICE
1	10,050	Low	5.34
		Average	6.93
		Accepted	6.54
2	3,200	Low	5.00
		Average	6.67
		Accepted	7.00
3	13,400	Low	4.95
		Average	5.48
		Accepted	4.95
5	375	Low	13.20
		Average	13.20
		Accepted	13.20
7 & 8	1,200	Low	9.53
		Average	11.76
		Accepted	10.95
9	1,100	Low	12.90
		Average	16.47
		Accepted	12.90
10	800	Low	7.75
		Average	11.64
		Accepted	9.44
12	950	Low	10.23
		Average	11.63
		Accepted	13.50

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TABLE IV.

RIP-RAP - CALUMET-SAG.

SECTION	SQUARE YARDS	BIDDER	UNIT PRICE PER SQ. YD.	EQUIV. UNIT PRICE PER CUBIC YARD
1	500	Low	.75	1.13
		Average	1.11	1.67
		Accepted	1.00	1.50
3	5,000	Low	.65	.98
		Average	1.05	1.58
		Accepted	1.00	1.50
4	37,000	Low	.50	.75
		Average	.96	1.44
		Accepted	.50	.75
5	59,000	Low	.50	.75
		Average	.75	1.13
		Accepted	1.00	1.50
9	70,000	Low	.75	1.13
		Average	1.24	1.86
		Accepted	.75	1.13
10	72,000	Low	.77	1.16
		Average	1.05	1.58
		Accepted	.77	1.16
11	70,000	Low	.65	.98
		Average	.88	1.32
		Accepted	.65	.98
12	25,000	Low	.65	.98
		Average	.80	1.20
		Accepted	.70	1.05

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Table No. 5.

CALUMET-SA

SUMMARY OF UNIT AND TOTAL CONTRACT COSTS O

SECTION	EARTH CUBIC YARDS	EARTH UNIT COST	EARTH TOTAL COST	ROCK CUBIC YARDS	ROCK UNIT COST	ROCK TOTAL COST
1	265,000)	.24	63,600.00	315,000	.89)	280,350.00
	55,000)	.30	16,500.00	315,000	.65)	204,750.00
2	221,000	.19	41,990.00	351,000	.83)	290,628.00
	-	-	-	351,000	.65)	228,150.00
3	335,000	.27	90,450.00	220,000	.90)	197,340.00
	-	-	-	220,000	.69)	151,800.00
4	780,000	.24	187,200.00	121,000	.70	84,700.00
5	1,070,000	.24	256,[illegible].00	141,000	.70	98,700.00
7 & 8	2,350,000	.425	998,750.00	15,000	.90	13,500.00
9	875,000	.285	249,375.00	50,000	1.15	57,500.00
10	670,000	.31	207,700.00	300,000	.62	186,000.00
11	750,000	.27	202,500.00	85,000	.65	55,250.00
12	485,000	.235	113,975.00	125,000	.85)	106,250.00
	-	-	-	125,000	.65)	81,250.00
Average Price		.309			.674 .865	
Total Cost			2,428,840.00			1,161,600.00 874,568.00
Total Ydge.	7,856,000			1,723,000 1,011,000		

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S OF LOWEST UNIT PRICE BID FOR EACH SECTION

PLAIN CONCRETE			RIP-RAP		
C YARDS	UNIT COST	TOTAL COST	CUBIC YARDS	UNIT COST	TOTAL COST
10,050	5.34	53,667.00	333	1.13	375.00
-	-	-	-	-	-
3,200	5.00	16,000.00	-	-	-
-	-	-	-	-	-
13,400	4.95	66,330.00	3,333	.98	3,250.00
-	-	-	-	-	-
-	-	-	24,667	.75	18,500.00
375	13.20	4,950.00	46,000	.75	34,500.00
1,200	8.53	10,236.00	-	-	-
1,100	12.90	14,190.00	46,667	1.13	52,500.00
800	7.75	6,200.00	48,000	1.16	55,400.00
-	-	-	46,667	.98	45,500.00
950	10.23	9,718.00	16,667	.98	16,250.00
-	-	-	-	-	-
	5.83			.974	
		181,291.00			226,275.00
31,075			232,334		

E: Rock prices in Sections 1, 2, 3 and 12 are shown with and without channeling.
The costs for rip-rap are shown on an equivalent cubic yard basis.

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Table No. 6.

CALUMET-S

AVERAGE OF ALL TENDERS (

	EARTH			ROCK		
SECTION	CUBIC YARDS	UNIT COST	TOTAL COST	CUBIC YARDS	UNIT COST	TOTAL COST
1	265,000 55,000	.329) .425)	87,185.00 23,375.00	315,000 315,000	1.046) .771)	329,490.00 242,865.00
2	221,000 -	.264 -	58,344.00 -	351,000 351,000	.965) .755)	255,735.00 265,601.00
3	335,000 -	.290 -	97,150.00 -	220,000 220,000	.947) .740)	206,340.00 162,800.00
4	780,000	.291	226,[illegible]	121,000	.792	95,832.00
5	1,070,000	.260	278,200.00	141,000	.720	101,520.00
7 & 8	2,350,000	.499	1,172,650.00	15,000	2.150	32,250.00
9	875,000	.420	367,500.00	50,000	1.268	63,400.00
10	670,000	.395	264,650.00	300,000	.660	208,000.00
11	750,000	.355	266,250.00	85,000	.927	78,795.00
12	485,000 -	.282 -	136,770.00 -	125,000 125,000	.966) .731)	120,750.00 91,375.00
Average Price		.379			.778 .904	
Total Cost			2,979,054.00			1,340,438.00 914,315.00
Total Yardage	7,856,000			1,723,000 1,011,000		

Appendix 13 .... 14.

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CIFIED ITEMS FOR EACH SECTION

PLAIN CONCRETE			RIP-RAP		
YARDS	UNIT COST	TOTAL COST	CUBIC YARDS	UNIT COST	TOTAL COST
10,050	6.93	69,345.00	333	1.67	557.00
-	-	-	-	-	-
3,200	6.67	21,344.00	-	-	-
-	-	-	-	-	-
13,400	5.48	73,432.00	3,333	1.575	5,250.00
-	-	-	-	-	-
-	-	-	24,667	1.44	35,520.00
375	13.20	4,950.00	46,000	1.13	51,750.00
1,200	11.76	14,112.00	-	-	-
1,100	16.47	18,117.00	46,667	1.86	86,800.00
800	11.64	9,312.00	48,000	1.58	75,798.00
-	-	-	46,667	1.32	61,600.00
950	11.63	11,048.00	16,667	1.20	20,000.00
-	-	-	-	-	-
	7.13			1.452	
		221,660.00			337,275.00
31,075			232,334		

COPY

Table No. 7.

CALUMET-

LOWEST TENDERS ON ENTIRE CONTRACTS. PRI

	EARTH			ROCK		
SECTION	CUBIC YARDS	UNIT COST	TOTAL COST	CUBIC YARDS	UNIT COST	TOTAL CO
1	265,000 55,000	.245) .350)	64,925.00 19,250.00	315,000 315,000	.890) .650)	280,350. 204,750.
2	221,000 -	.220 -	48,620.00 -	351,000 351,000	.828) .650)	290,628. 228,150.
3	335,000 -	.290 -	97,150.00 -	220,000 220,000	.897) .690)	197,340. 151,800.
4	780,000	.2[illegible]0	19[illegible],0[illegible]0.00	121,000	.770	93,170.
5	1,070,000	.240	256,800.00	141,000	.700	98,700.
7 & 8	2,350,000	.425	1,065,039.00	15,000	1.900	28,500.
9	875,000	.2875	251,562.00	50,000	1.250	62,500.
10	670,000	.326	218,420.00	300,000	.690	207,000.
11	750,000	.292	219,000.00	85,000	.650	55,250.
12	485,000 -	.255 -	123,675.00 -	125,000 125,000	.928) .700)	116,000. 87,500.
Average Price		.326			.706 .875	
Total Cost			2,559,441.00			1,217,320. 884,318.
Total Yariage	7,856,000			1,723,000 1,011,000		

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

Appendix 15 .... 15.

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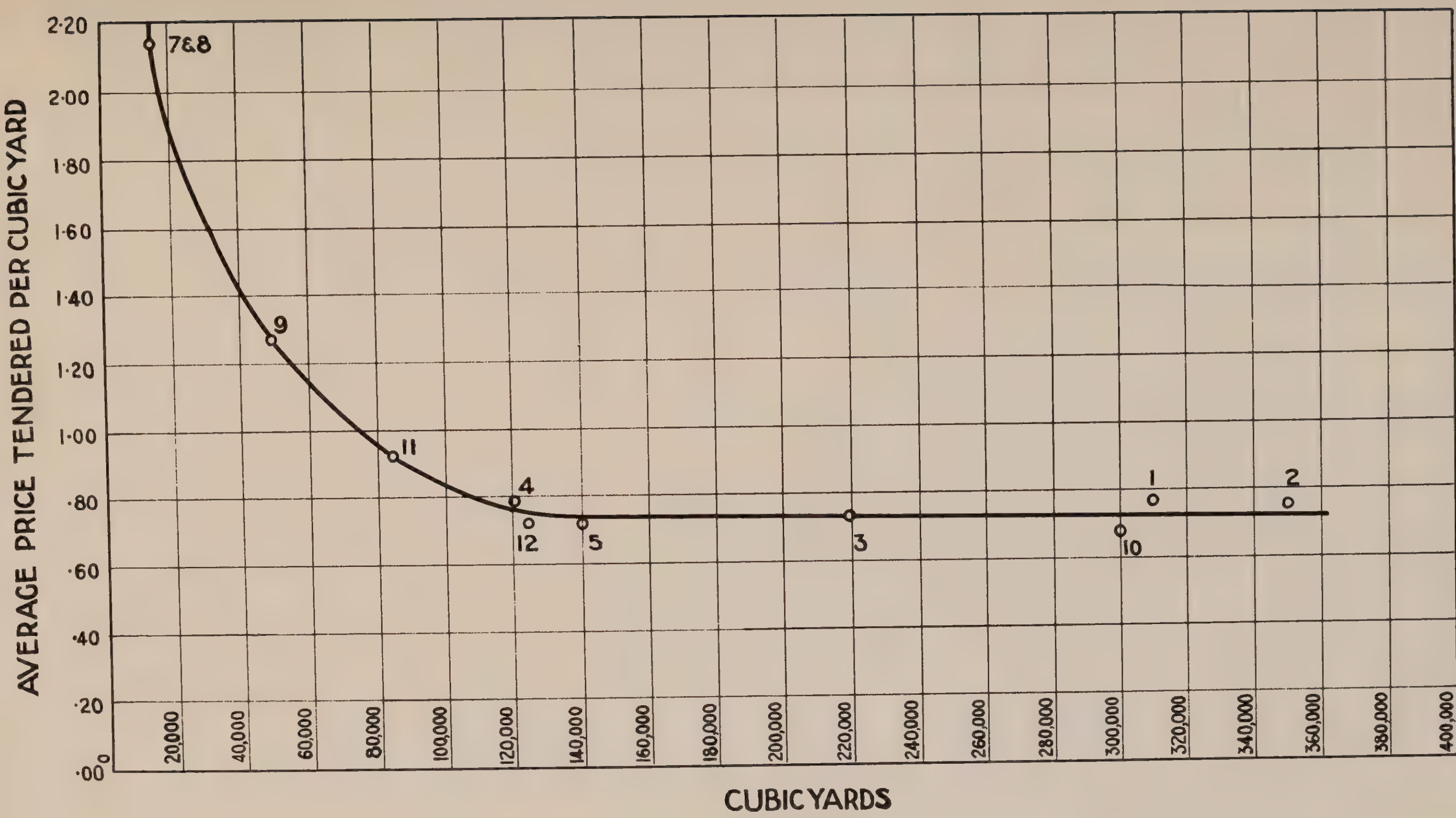
ACCEPTED TENDERS FOR EACH SECTION

PLAIN CONCRETE			RIP-RAP		
BIC YARDS	UNIT COST	TOTAL COST	CUBIC YARDS	UNIT COST	TOTAL COST
10,050	6.54	65,727.00	333	1.50	500.00
-	-	-	-	-	-
3,200	7.00	22,400.00	-	-	-
-	-	-	-	-	-
13,400	4.95	66,330.00	3,333	1.50	5,000.00
-	-	-	-	-	-
-	-	-	24,667	.75	18,500.00
375	13.20	4,950.00	46,000	1.50	69,000.00
1,200	10.95	13,140.00	-	-	-
1,100	12.90	14,190.00	46,667	1.13	52,500.00
800	9.44	7,552.00	48,000	1.16	55,400.00
-	-	-	46,667	.98	45,500.00
950	13.50	12,825.00	16,667	1.05	17,500.00
-	-	-	-	-	-
	6.66			1.136	
		207,114.00			263,900.00
31,075			232,334		

COPY

OTE: Rock prices in Sections 1, 2, 3 and 12 are shown with and without channel ing.
The rip-rap total shows the equivalent cost on a yardage basis.



APPENDIX 13 – CHART A

RELATION BETWEEN QUANTITIES AND UNIT PRICES

ROCK EXCAVATION–CALUMET SAG CANAL
(AVERAGE OF BIDS ON ROCK IN EACH CONTRACT)

June, 1923.

Re-drawn by Walter J. Francis & Company,
Consulting Engineers, August, 1923.

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

APPENDIX 14.

EARTH COSTS IN 1917, AND EARTH AND ROCK COSTS IN 1917, 1918 AND 1919

From an examination of the charts it will be seen that the Commission actually took out earth excavation in 1917 and 1918 at less than estimated cost, and had the material excavated been normally dry, and had shovels Nos. 1 and 2 been delivered promptly, the average cost of earth excavation would have closely approached the estimate, even though it was abnormally wet.

As soon as Nos. 1 and 2 shovels got in commission the effect was at once demonstrated, and at this juncture it should be considered that the estimated price per cubic yard was that for which the large shovels were to be the excavating units for the greater part of the yardage. It will also be fairly well established that even had the man-hour rate remained at the maximum figure of 1917, and had the large shovels been delivered promptly and worked continuously, the price of 30¢ to 35¢ per yard would have been the actual cost of earth, even up to the end of 1918.

COPY

The price of 62.2¢ appearing for 1919 was to a great extent due to the high man-hour rate and inefficiency of labor, but at the time the cost began to rise abnormally, in April 1919, it was confidently expected that a pronounced drop in labor and material costs was overdue and was expected at any time. Furthermore, at this time there remained 80% of the earth excavation to be done, together with the whole of the canal rock and concrete, and the abnormal rise in cost would only be applicable to the small amount of work done up to that time, and would easily be absorbed in the great bulk of the work to be done under anticipated normal conditions.

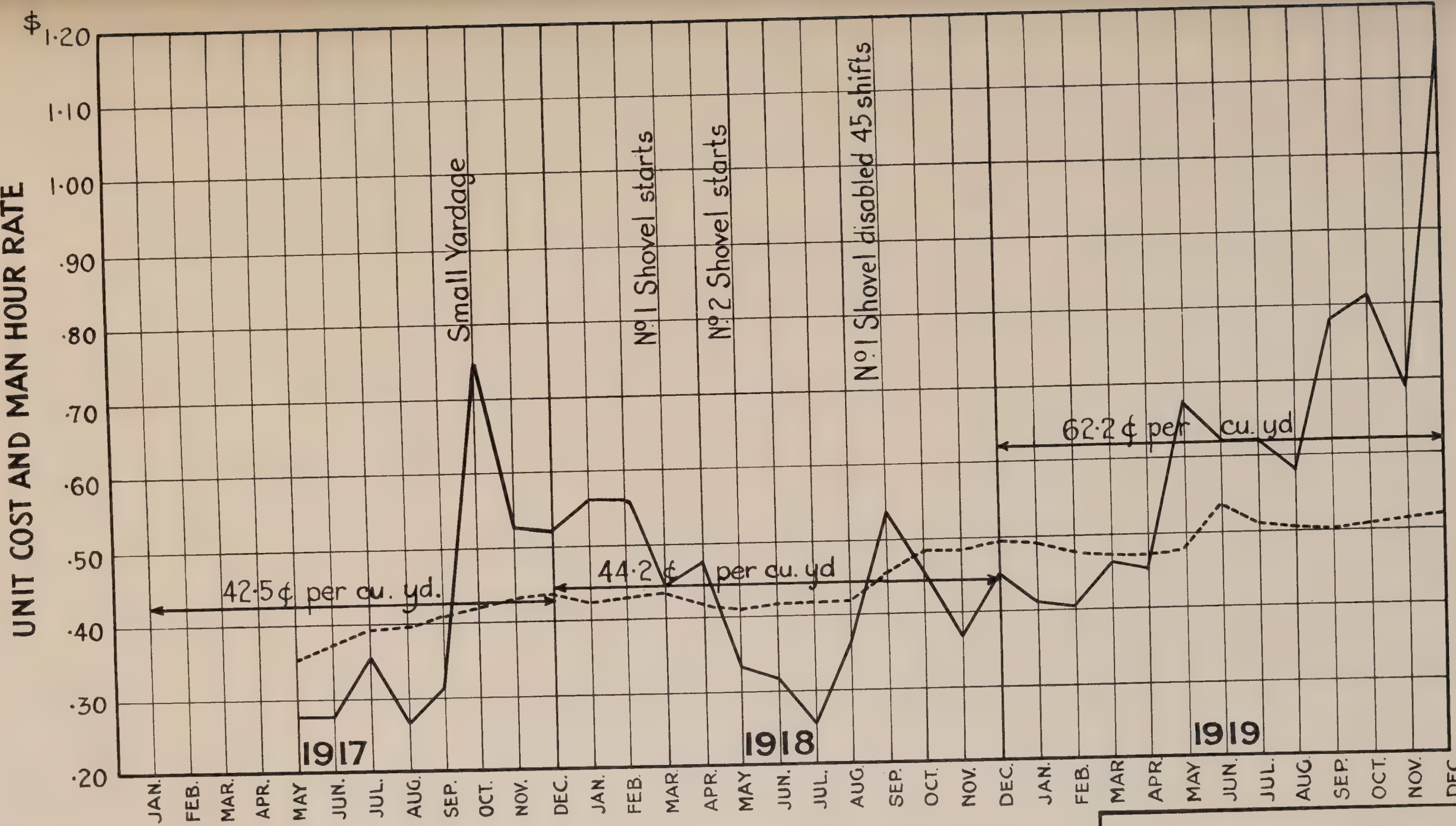
A P P E N D I X 18.

[illegible] IN 1917, AND [illegible] [illegible] IN 1917, 1918 AND 1919

From an examination of the records it will be seen that the Commission actually took out earth excavation in 1917 and 1918 at <u>less than estimated cost</u>, and had the material excavated been normally dry, and had shovels Nos. 1 and 2 been delivered promptly, the average cost of earth excavation would have closely approximated the estimate, even though it was abnormally wet.

As soon as Nos. 1 and 2 shovels got in commission the effect was at once demonstrated, and at this [illegible] of [illegible] it is considered that the estimated price per cubic yard was what the large shovels were to be the excavating units for the greater part of the yardage. It will also be fairly well established that even had the man-hour rate remained at the average figure of 1917, and had the large shovels been delivered promptly and worked continuously, the price of 35¢ to 40¢ per yard would have been the actual cost of earth, even up to the end of 1918.

The price of $2.00 excavating for 1919 was to a great extent due to the high man-hour rate and inefficiency of labor, but at the time the cost began to rise abnormally, in April 1918, it was confidently expected that a pronounced drop in labor and material costs was overdue and was expected at any time. Furthermore, at this time there remained 60% of the earth excavation to be done, together with the whole of the canal rock and concrete, and the abnormal rise at that time would only be applicable to the small amount of work done up to that time, and would easily be absorbed in the great bulk of the work to be done under anticipated normal conditions.

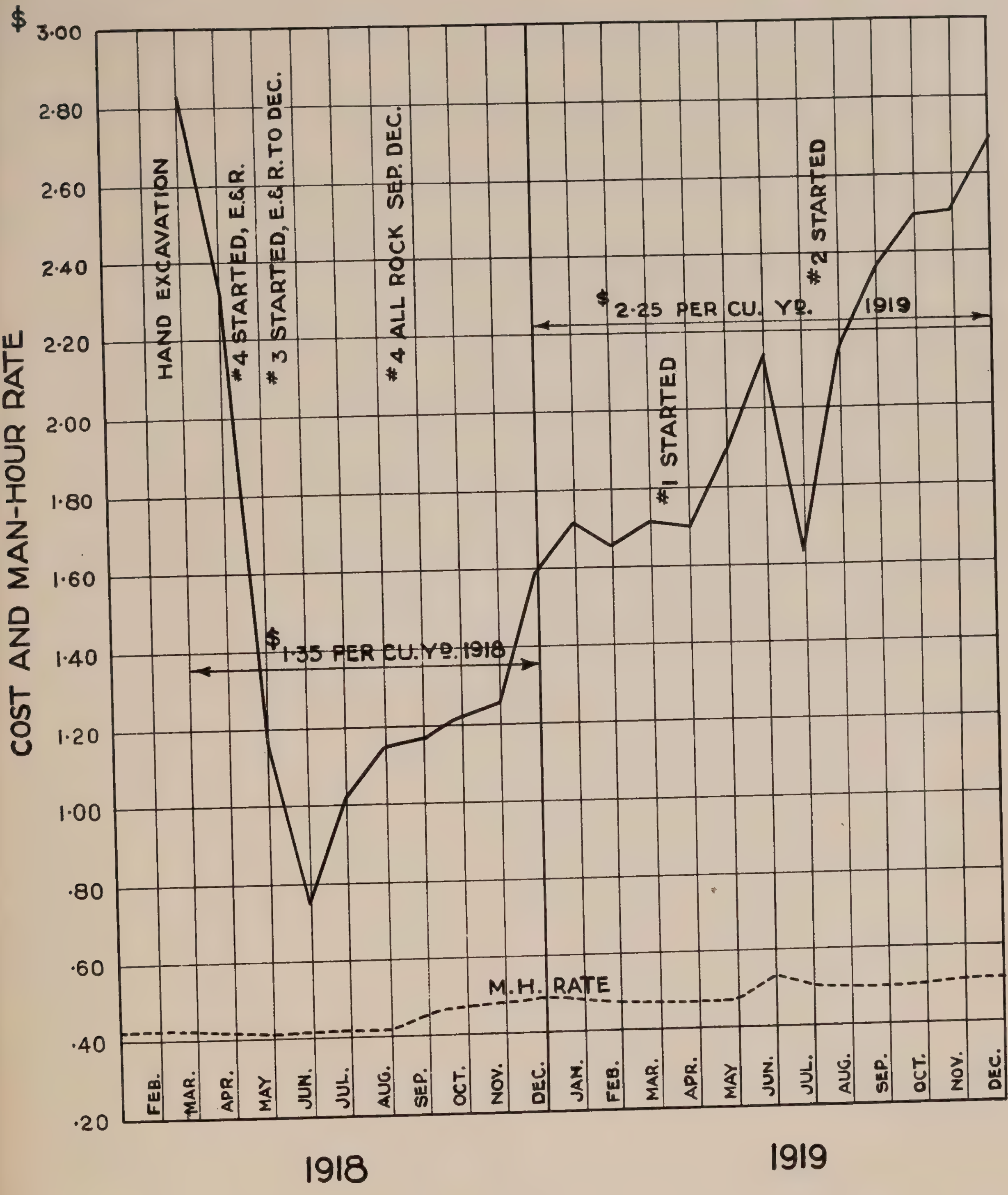


NOTE EFFECT OF LARGE SHOVELS BEGINNING IN MARCH AND MAY, 1918, ALTHOUGH MAN HOUR RATE HAS INCREASED.

Re-drawn by Walter J. Francis & Company Consulting Engineers August, 1923.

APPENDIX No. 14
UNIT COSTS EARTH EXCAVATION 1917, 1918, 1919.

July, 1923.



APPENDIX 14

UNIT COST, ROCK EXCAVATION 1918 AND 1919

July, 1923.

Re-drawn by Walter J. Francis & Company,
Consulting Engineers, August, 1923.

WALTER J. FRANCIS & COMPANY.

COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

APPENDIX 15.

Comparison of direct working force and cost in rock before single shifting in 1921 with a day of equal rock production after single shifting. Also comparison of single shift shovel production in 1921 as compared with day shift on double shift basis tabulation.

The following tabulation shows a listing of the direct labor component of a cubic yard of rock for the period 1921, listed monthly, and takes in all the rock excavated in that period, during which time the double shift was discontinued and the single shift started.

COPY

DOUBLE 10 HR. SHIFT

1921	DIRECT LABOR	QUANTITY
Jan.	.615	92,108
Feb.	.424	164,711
Mar.	.279	231,016
Apr.	.352	247,460
May	.413	257,491
June	.373	296,662
July	.431	276,101
Cost per Cu. Yd.	.374¢	1,565,549

SINGLE 10 HR. DAY SHIFT

1921	DIRECT LABOR	QUANTITY
Aug.	.280	192,160
Sept.	.242	179,477
Oct.	.215	220,426
Nov.	.210	157,599
Dec.	Nothing of importance.	
Cost per Cu. Yd.	.238¢	749,652

The above Direct Labor figures show a very pronounced change in favor of the single shift construction procedure, and covers prices ranging over 2,000,000 cubic yards of rock excavation taken out by our combined rock excavating shovels, during the year 1921.

The reduction in favor of single shift shows 37% on Direct Labor. However, this reduction in Direct Labor would apply to as great an extent on materials

A P P E N D I X A.

Comparison of direct [illegible] and cost in cents before single shifting in 1921 with a day of equal yard production after single shifting. Also comparison of single shift shovel production in 1921 as compared with day shift on double shift basis tabulation.

The following tabulation shows a listing of the direct labor component of a cubic yard of [illegible] for the period 1921, figured monthly, and taken in all the yard excavated in that period, during which time the double shift was discontinued and the single shift set up.

[illegible]				[illegible]		
1921	Direct Labor	Yardage		1921	Direct Labor	Yardage
Jan.	.515	92,108		Aug.	.200	192,160
Feb.	.484	164,711		Sept.	.262	175,477
Mar.	.279	231,916		Oct.	.215	220,436
Apr.	.362	247,469		Nov.	.210	167,899
May	.415	217,491		Dec.	Nothing of importance.	
June	.275	233,992				
July	[illegible]	[illegible]				
Cost per [illegible]	.37½	1,565,049		Cost per [illegible]	.235¾	749,036

The above direct labor figures show a very pronounced change in favor of the single shift [illegible] procedure, and covers prices ranging over 2,000,000 cubic yards of yard excavation taken out by the [illegible] vating shovels, during the year 1921.

The reduction in favor of single shift shows [illegible] on direct labor. However, this reduction in direct labor would apply to as great an extent on materials

Appendix 15 ..... 2.

and plant, in that the reasons for the reduction in labor would curtail the necessity for material and plant, this especially being so in the case of the lighting systems employed for night service only, and in the application of repairs, which are more economical during the quiet period of fourteen (14) hours in every twenty-four (24), by reason of the fact that a small gang can work steadily and maintain the plant in fourteen (14) hours out of the twenty-four (24) much more efficiently than the large gang necessary for rush repair work in the four (4) hours between the two ten-hour shifts of the twenty-four (24).

Also see comments from the following letter:

COPY

Mr. Bradley, September 14th, 1921.

Mr. Acres.

Production Records in Earth, Rock and Concrete on the Double Shift Method; as Compared with the same Period Single Shift, and applying the Labor Reduction recently placed into effect.

Dear Sir:

Average yardage of the past double shift rush period compared with our single shift present period, shows improvement in yardage results on our excavating plants in favor of the single shift (covering a month and a half test) of 26%.

Our actual labor reductions of 15% coupled with the 26% efficiency increase, by day work only, has shown an actual effect of 37% reduction of labor costs for earth and rock, comparing July and August.

This improved efficiency on single shift was realized <u>without any change whatever</u> in the personell of the <u>supervisory organization</u> or in the <u>working procedure</u>.

A P P E N D I X 16.

ANALYSIS OF THE UNIT COST OF EARTH AND ROCK EXCAVATION IN CANAL, FOREBAY AND SCREEN-HOUSE, UTILIZING TWO 225-B BUCYRUS AND TWO 103-C BUCYRUS ELECTRIC SHOVELS.

In the following, the investigation will be considered under two divisions; namely, (a) a comparison of actual unit costs with those which would have obtained by using the shovels at their originally estimated capacities, and (b) a comparison of the actual unit costs with those which would have obtained by using the shovels at their actual maximum capacities. These comparisons will be made under the following conditions:

1. - That consideration only will be given to the four shovels as originally purchased; namely, two 225-B and two 103-C Bucyrus electric shovels.

2. - The shovels to be used only in canal, forebay and screen house as originally planned.

3. - First, that the shovels work at their originally estimated capacities which are as follows:

225-B in earth	- 5,000	cubic	yards	per	day	of	10	hours
225-B in rock	- 3,000	"	"	"	"	"	"	"
103-C in earth	- 3,500	"	"	"	"	"	"	"
103-C in rock	- 2,000	"	"	"	"	"	"	"

and second, that the shovels be utilized at their actual maximum capacities which are as follows:

No. 1 in earth on April 10th, 1919 had a ten hour output of 5,180 cubic yards bank measurement.

No. 2 in earth on March 4th, 1919 had a ten hour output of 4,060 cubic yards bank measurement.

[illegible]

[illegible]

In the following, the investigation will be considered under two divisions; namely, (a) a comparison of actual unit costs with those which would have obtained by using the shovels at their originally estimated capacities, and (b) a comparison of the actual unit costs with those which would have obtained by using the shovels at their actual maximum capacities. These comparisons will be made under the following conditions:

COPY

1. - That consideration only will be given to the four shovels as originally contracted; namely, two 225-B and two 125-C Bucyrus electric shovels.

2. - The shovels to be used only in [illegible] as originally planned.

3. - First, that the shovels work at their originally estimated capacities which are as follows:

225-B in earth - 3,600 cubic yards per day of 16 hours
225-B in rock - 3,000 " " " " " " "
125-C in earth - 3,300 " " " " " " "
125-C in rock - 2,000 " " " " " " "

and second, that the shovels be utilized at their actual maximum capacities which are as follows:

No. 1 in earth on April 18th, 1919 had a ten hour output of 6,252 cubic yards bank measurement.

No. 2 in earth on March 4th, 1919 had a ten hour output of 4,060 cubic yards bank measurement.

Appendix 16 ..... 2.

No. 3 in earth on September 28th, 1920 had a ten hour output of 2,950 cubic yards bank measurement.

No. 4 in earth on January 7th, 1921 had a ten hour output of 2,567 cubic yards bank measurement.

No. 1 in rock on March 22nd, 1920 had a ten hour output of 1,792 cubic yards bank measurement.

No. 2 in rock on June 25th, 1921 had a ten hour output of 2,000 cubic yards bank measurement.

No. 3 in rock on April 30th, 1919 had a ten hour output of 1,865 cubic yards bank measurement.

No. 4 in rock on January 6th, 1919 had a ten hour output of 1,782 cubic yards bank measurement.

This gives a mean for shovels Nos. 1 and 2 in earth of 4,620 cubic yards per day of ten hours, and Nos. 3 and 4 in earth, 2,759 cubic yards per day of ten hours. The mean of Nos. 1 and 2 in rock was 1,896 cubic yards per day of ten hours, and Nos. 3 and 4 in rock, 1,824 cubic yards per day of ten hours.

4. That the shovels work day shift only for 310 days per year and ten hours per day.

5. That the 103-C type in rock is limited to the removal of the first 10 ft. over the canal, forebay and screen-house.

6. That the final actual quantities of excavation be used, which are as follows:

	EARTH	ROCK
Canal	9,651,557 c.y.	3,840,378 c.y.
Forebay	49,082 "	473,590 "
Screen-house	1,526 "	43,470 "
	9,702,165 c.y.	4,357,438 c.y.

7. The rock for the 103-C type will be approximately 811,000 cubic yards, leaving 3,546,438 cubic yards of rock to be removed by the 225-B type.

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Appendix 16 ..... B.

8. That the date for the beginning of this excavation will be taken as April 1st, 1918, when delivery of the first large plant order was completed.

UNIT COSTS WITH SHOVELS AT ORIGINALLY ESTIMATED CAPACITY.

	EARTH	ROCK
2-103-C in rock for 203 days at 2,000 cubic yards per day each	-	811,000
2-103-C in earth for 388 days at 3,500 cubic yards per day each	2,716,000	-
2-103-C in earth for 411 days at 3,500 cubic yards per day each	2,877,000	-
2-225-B in rock for 591 days at 3,000 cubic yards per day each	-	3,546,438
2-225-B in earth for 411 days at 5,000 cubic yards per day each	4,109,165	
	9,702,165	4,357,438

COPY

Thus, the total time for these shovels is 591+411 days = 1,002 days, and 1,002 days from April 1st, 1918 will give about July 1st, 1921 as the date of completion of the excavation.

The unit costs of rock and earth excavation taken out by these shovels if working at originally estimated capacities are obtained by utilizing the actual total costs accumulated against the shovels in question, against these estimated capacities. The actual unit cost is also stated.

1. SHOVELS IN EARTH EXCAVATION.

(1) - 225-B TYPE:

Under actual conditions, No. 1 worked 418 ten hour shifts, and No. 2 worked

867 ten hour shifts, or a total of 1,285 ten hour shifts for this type of shovel, in earth. The total actual cost of excavation and disposal for these two shovels was $1,468,900.15, which was 2,255,050 cubic yards at 64.2 cents per cubic yard. The cost per ten hour shift = $1,213.10 which at estimated capacity of 5,000 cubic yards per shift = 24.3 cents per cubic yard.

(2) - 103-C TYPE:

Under actual conditions, No. 3 worked 1,317 ten hour shifts, and No. 4 worked 523 ten hour shifts, or a total of 1,840 ten hour shifts for this type of shovel, in earth. The total actual cost of excavation and disposal for these two shovels was $1,655,134.59, which is 1,422,772 cubic yards at $1.17 per cubic yard. The cost per ten hour shift = $900.00, which at the originally estimated capacity of 3,500 cubic yards per ten hours = 25.7 cents per cubic yard.

FOR ALL FOUR SHOVELS:

The amount of earth assigned to the two 225-B shovels in this estimated procedure is 4,109,165 cubic yards, which at 24.3 cents = $998,527.10, and for the two 103-C shovels is 5,593,000 cubic yards, which at 25.7 cents = $1,437,401.00, a total of $2,435,928.10, or a general average of 9,702,165 cubic yards of earth at 25.1 cents per cubic yard.

2. SHOVELS IN EARTH EXCAVATION.

(1) - 225-B TYPE:

Under actual conditions No. 1 worked 1,418 ten hour shifts, and No. 2 worked

Appendix 16 ..... 5.

945 ten hour shifts, or a total of 2,363 ten hour shifts for this type of shovel, <u>in rock</u>. The <u>total actual cost</u> of excavation and disposal for these two shovels was $8,062,083.95 which is 2,377,749 cubic yards at $3.39 per cubic yard. The cost per ten hour shift = $3,411.80, which at the originally <u>estimated capacity</u> of 3,000 cubic yards per ten hours = $1.1373 per cubic yard.

<u>(2) - 103-C TYPE</u>:

Under <u>actual</u> conditions, No. 3 worked 371 ten hour shifts and No. 4 worked 661 ten hour shifts, or a total of 1,032 ten hour shifts for this type of shovel, <u>in rock</u>. The total cost of excavation and disposal of these two shovels was $1,594,645.45 which is 505,376 cubic yards at $3.16 per cubic yard. The cost per ten hour shift = $1,545.20 which at the originally <u>estimated capacity</u> of 2,000 cubic yards per shift = 77.26 cents per cubic yard.

<u>FOR ALL FOUR SHOVELS</u>:

The amount of rock assigned to the two 225-B shovels in this originally estimated procedure is 3,546,438 cubic yards at $1.1373 = $4,159,971.77, and for the two 103-C shovels is 811,000 cubic yards, which at 77.26 cents = <u>$626,578.60</u>, a total of $4,786,550.37, or a general average of 4,357,438 cubic yards <u>of rock</u> at $1.099 per cubic yard.

WALTER J. FRANCIS & COMPANY.

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Appendix 16 ..... 6.

UNIT COSTS WITH SHOVELS AT ACTUAL MAXIMUM CAPACITY.

	EARTH	ROCK
2-103-C shovels in rock for 222 days at 1,824 cubic yards per day each	-	811,000
2-225-B shovels in rock for 935 days at 1,896 cubic yards per day each	-	3,546,438
2-103-C shovels in earth for 713 days at 2,759 cubic yards per day each	3,934,334	-
2-103-C shovels in earth for 391 days at 2,759 cubic yards per day each	2,157,538	-
2-225-B shovels in earth for 391 days at 4,620 cubic yards per day each	3,610,293	-
	9,702,165	4,357,438

Thus, the total time for all shovels will be 935+391 days = 1,326 days, which from April 1st, 1918 is equal to four seasons of 310 days of ten hours each + 86 days, giving an approximate date for the completion of the excavation of July 10th, 1922.

Utilizing the total cost chargeable to shovels working in excavation against the actual maximum capacities, the following indicates the unit costs resulting:

1. SHOVELS IN EARTH EXCAVATION.

(1) - 225-B TYPE:

Under actual conditions, No. 1 worked 418 ten hour shifts, and No. 2 worked 867 ten hour shifts, or a total of 1,285 ten hour shifts for this type of shovel, in earth. The total cost of excavation and disposal for these two

WALTER J. FRANCIS & COMPANY.
COPY FOR ENCLOSURE TO Mr. J. Allan Ross.

shovels was $1,468,900.15, which is 2,255,050 cubic yards at 64.2 cents per cubic yard. The cost per shift = $1,213.10, which at the actual maximum capacity of 4,620 cubic yards per ten hours = 26.3 cents per cubic yard.

(2) - 103-C TYPE:

Under actual conditions, No. 3 worked 1,317 ten hour shifts, and No. 4 worked 523 ten hour shifts, or a total of 1,840 ten hour shifts for this type of shovel, in earth. The total cost of excavation and disposal for these two shovels was $1,655,134.69, which is 1,422,772 cubic yards at $1.17 per cubic yard. The cost per ten hour shift = $900.00, which at actual maximum capacity of 2,759 cubic yards per ten hour shift = 32.6 cents per cubic yard.

(3) - FOR ALL FOUR SHOVELS:

The amount of earth assigned to the two 225-B shovels under this estimated procedure is 3,610,293 cubic yards, which at 26.3 cents = $949,507.06, and for the two 103-C is 6,091,872 cubic yards which at 32.6 cents = $1,985,950.27, a total of $2,935,457.77, or a general average of 9,702,165 cubic yards of earth at 30.26 cents per cubic yard.

2. SHOVELS IN ROCK EXCAVATION.

(1) - 225-B TYPE:

Under actual conditions, No. 1 worked 1,418 ten hour shifts, and No. 2 worked 945 ten hour shifts, or a total of 2,363 ten hour shifts for this type of shovel in rock. The total cost of excavation and disposal for these two shovels was $8,062,083.95 which is 2,377,749 cubic yards at $3.39 per cubic

yard. The cost per shift = $3,411.80 which at the actual maximum capacity of 1,896 cubic yards per ten hour shift is $1.80 per cubic yard.

(2) - 103-C TYPE:

Under actual conditions, No. 3 worked 371 ten hour shifts, and No. 4 worked 661 ten hour shifts, or a total of 1,032 ten hour shifts for this type of shovel, in rock. The total cost of excavation and disposal of these two shovels was $1,594,645.45 which is 505,376 cubic yards at $3.15 per cubic yard. The cost per ten hour shift = $1,545.20, which at the actual maximum capacity of 1,824 cubic yards per ten hours = 90.2 cents per cubic yard.

(3) - FOR ALL FOUR SHOVELS:

COPY

The amount of rock excavation assigned to the two 225-B shovels in this estimated procedure is 3,546,438 cubic yards, which at $1.80 = $6,383,588.46, and for the two 103-C is 811,000 cubic yards, which at 90.4 cents = $731,522.00, or 4,357,438 cubic yards at $1.63 per cubic yard = $7,115,110.40, or a general average of 4,357,438 cubic yards of rock at $1.63 per cubic yard.

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SUMMARY

SHOVELS	ACTUAL UNIT COST		(A) UNIT COST AT EST. CAPACITY		(B) UNIT COST AT ACTUAL MAX-IMUM CAPACITY	
	EARTH	ROCK	EARTH	ROCK	EARTH	ROCK
225-B Nos.	.642	-	.243	-	.263	-
1 and 2	-	3.390	-	1.137	-	1.800
103-C Nos.	1.170	-	.257	-	.326	-
3 and 4	-	3.160	-	.7726	-	.902
All shovels	.849	-	.251	-	.3026	-
	-	3.350	-	1.0990	-	1.630

It therefore appears from the above that the unit costs with originally estimated capacities are actually less than the original 1917 estimates. These unit costs are obtained by using all actual costs chargeable to the shovels, working in rock and earth excavation, against the originally estimated capacities of the shovels, and show that had anticipated shovel capacities been realized and maintained, the actual cost of excavation would have been less than that estimated in 1917, even though handicapped by the inflated prices of labor and material. Furthermore, the date of completion under day shift work only, with the original plant, would have been about July 1st, 1921, which would have been sufficiently early to provide for the admission of water into the canal by September 1st, 1921, and would have completed the 6,500 second foot canal well within the three year limit originally estimated but not scheduled.

Also, the unit costs utilizing the shovels at the actual maximum capacities, are obtained in a similar way, that is, by including all possible charges

against earth and rock excavation by these shovels, against the actual maximum capacities of the shovels. It will be seen that the actual production of one of these 225-B shovels on April 10th, 1919 actually exceeded the estimated capacity by 180 cubic yards in ten hours, even though rip-rap was placed to hold the banks, indicating that had the excavation been normal, the average output in earth could have been made equal to that estimated, working day shift only, especially by utilizing the leeway given by working 310 days per year instead of 250 days as estimated.

These unit values also indicate that the earth excavation would have been less than that estimated and the rock about 35% higher; that is, by using estimated 1917 prices of 33-½ cents per cubic yard for earth and $1.21½ per cubic yard for rock.

These four shovels would have completed the excavation for canal, forebay and screen-house by July 1st, 1922 working day shift only. In equity, it should be stated that the actual total costs used in the above computations included night shift work, and the basis upon which the foregoing analysis is made assumes that the greater night costs are absorbed in the equivalent day shift costs. This would seem to indicate that had it been feasible to secure the actual day costs, the unit prices resulting would have been even lower than those above set forth.

EARTH EXCAVATION

TABLE OF MAXIMUM SHOVEL CAPACITIES 10 hour shift.

SHOVEL NO. 1 Month and Year	SHOVEL NO. 1 Actual C.Y. Max. Cap.	SHOVEL NO. 2 Month and Year	SHOVEL NO. 2 Actual C.Y. Max. Cap.	SHOVEL NO. 3 Month and Year	SHOVEL NO. 3 Actual C.Y. Max. Cap.	SHOVEL NO. 4 Month and Year	SHOVEL NO. 4 Actual C.Y. Max. Cap.
Apr. 1,1919	3400	Jan.27,1919	3392	Oct.24,1919	2465	-	-
" 2,1919	3400	" 28,1919	3328	Sept.2,1920	2890	Nov. 3,1920	1972
" 3,1919	3370	" 29,1919	3312	" 16,1920	2628	" 5,1920	2023
" 5,1919	3944	Feb. 3,1919	3584	" 17,1920	2944	" 8,1920	1955
" 5,1919	3644	" 12,1919	3600	" 28,1920	3030	" 9,1920	2176
" 6,1919	3842	" 13,1919	3520	" 29,1920	2932	Dec.16,1920	1920
" 7,1919	4165	" 18,1919	3618			" 31,1920	2246
" 7,1919	3570	" 20,1919	3600			Jan. 3,1921	2240
" 9,1919	4216	Mar. 4,1919	3898			" 7,1921	2272
" 10,1919	4930	Apr. 4,1919	3705				
" 10,1919	3570	Aug. 5,1919	3857				
" 11,1919	4199						
" 11,1919	3740						
" 12,1919	4313						
" 12,1919	4080						

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Average - 4100-(corrected) 3730-(corrected) 2722-(corrected) 2390-(corrected)

Shovel No. 1 - Maximum (car measurement) April 10th,1919 .. 4,930 c.y. per shift
Corrected to bank measurement 5,180

Shovel No. 2 - Maximum (car measurement) May 4th, 1919 .... 3,898 " "
Corrected to bank measurement .... 4,060 " "

Shovel No. 3 - Maximum (car measurement) September 28th, 1920 .... 3,030 " "
Corrected to bank measurement .... 2,950 " "

Shovel No. 4 - Maximum (car measurement) January 7th,1921 . 2,272 " "
Corrected to bank measurement .... 2,567 " "

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ROCK EXCAVATION

TABLE OF MAXIMUM SHOVEL CAPACITIES 10 hour shift.

SHOVEL NO. 1		SHOVEL NO. 2		SHOVEL NO. 3		SHOVEL NO. 4	
Month and Year	Actual C.Y. Max. Cap.	Month and Year	Actual C.Y. Max. Cap.	Month and Year	Actual C.Y. Max. Cap.	Month and Year	Actual C.Y. Max. Cap.
May 2,1920	1700	Apr.14,1921	1687	Apr.25,1919	1366	Nov.14,1918	1404
" 19, "	1760	" 21, "	1644	" 30, "	1582	Jan. 3,1919	1260
" 22, "	1830	" 26, "	1736	May 6, "	1282	" 4, "	1568
Oct.27, "	1826	June 2, "	1794			" 6, "	1680
Mar.29,1921	1683	" 5, "	1840				
		" 24, "	1817				
		" 26, "	1874				
Average -	1724-(corrected)		1835-(corrected)		1650-(corrected)		1567-(corrected)

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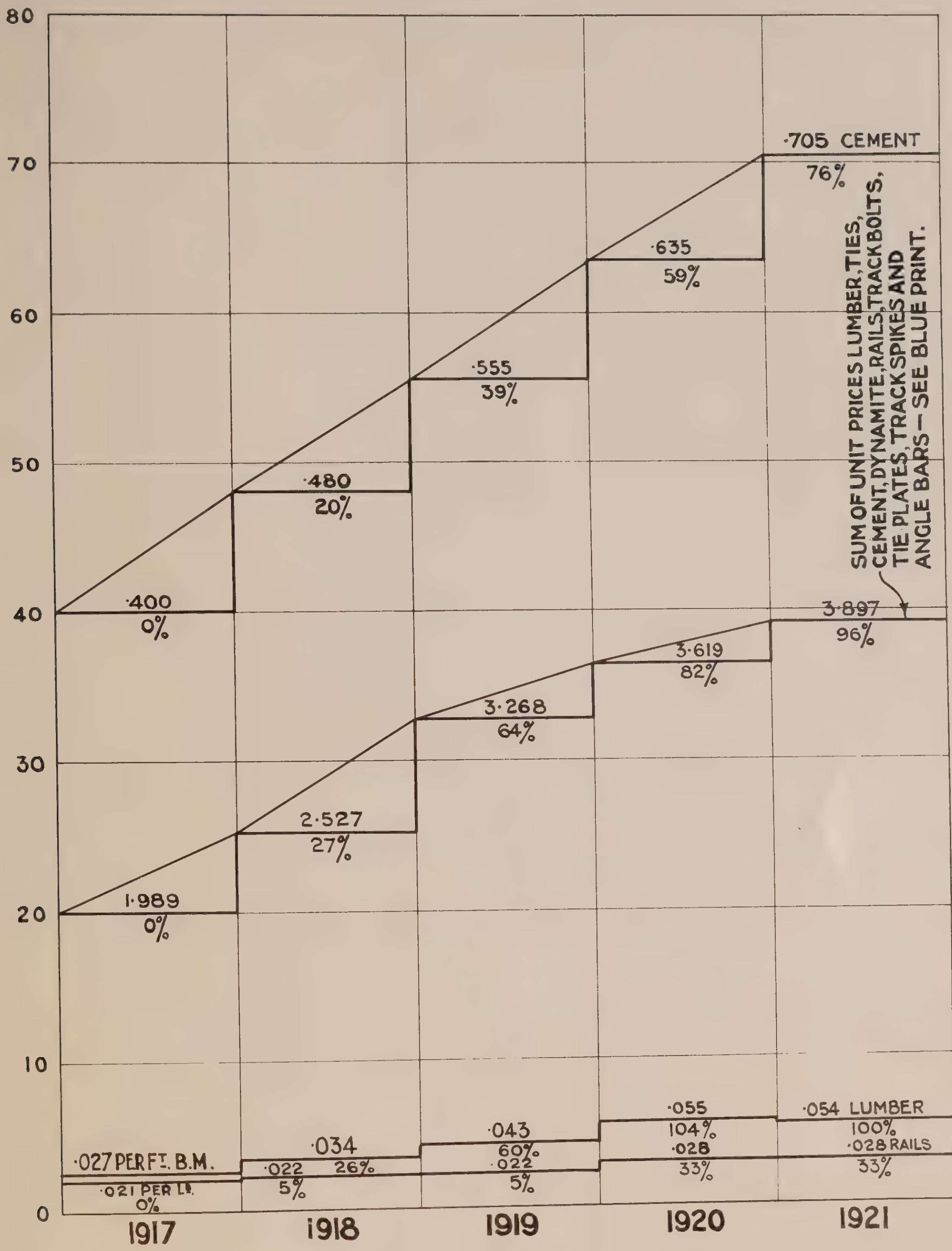
Shovel No. 1 - Maximum (car measurement) May 2nd, 1920 .. 1,830 c.y. per shift
Corrected to bank measurement 1,792

Shovel No. 2 - Maximum (car measurement) June 26th, 1921. 1,874 " "
Corrected to bank measurement .... 2,000 " "

Shovel No. 3 - Maximum (car measurement) April 30th,1919. 1,582
Corrected to bank measurement .... 1,860 " "

Shovel No. 4 - Maximum (car measurement) January 6th, 1919 .... 1,680 " "
Corrected to bank measurement .... 1,782 " "



APPENDIX 17

TO ACCOMPANY BLUE PRINT OF UNIT AND TOTAL COST OF IMPORTANT CONSTRUCTION MATERIALS FOR YEARS 1917–1921 INCLUSIVE

July, 1923.

Re-drawn by Walter J. Francis & Company,
Consulting Engineers, August, 1923.

ANSWERS TO QUESTIONS ITEMIZED IN MR. BOWER'S LETTER
TO MR. POPE OF JUNE 14TH, 1923.

Question 1: On what information were unit prices used in the original estimate and referred to by Mr. Gaby in his report to the Chairman of the Commission under date of January 11th, 1917, based?

Answer: The units prices in the estimate referred to were derived by the ordinary process of engineering experience, analogy, and precedent. Two outstanding examples of the data which had some bearing on establishment of these prices were the unit prices obtaining on the Calumet-Sag contracts on the Chicago drainage canal in 1916 and the rock excavation in the Livingston Channel of the Detroit River.

Full data in connection with these above works is set forth in Mr. Goodwin's report on excavation methods which is already in the hands of the Commissioners, and a more extended analysis of these same contracts and prices is contained in Mr. Acres' answers to the contractors' evidence.
(See also transcription of Mr. Acres' recent evidence before the Commission).

Question 2: By what percentage was it anticipated that the use of extra large shovels and electrically driven equipment would reduce the cost of rock and earth excavation?

WALTER J. FRANCIS & COMPANY
[illegible] Mr. J. Allan Ross.

(-3-)

ANSWERS TO QUESTIONS CONTAINED IN MR. [illegible]'S LETTER
TO MR. [illegible] OF JUNE 14TH, 1923.

Question 1: On what information were unit prices used in the original estimate and referred to by Mr. Daly in his report to the Chairman of the Commission under date of January 11th, 1917, based?

Answer: The unit prices in the estimate referred to were derived by the ordinary process of engineering experience, analogy, and precedent. The outstanding examples of the data which had some bearing on establishment of these prices were the unit prices obtaining on the Columbia-[illegible] contracts on the Chicago Drainage canal in 1910 and the rock excavation in the Livingston Channel of the Detroit River.

Full data in connection with these above works is set forth in Mr. [illegible]'s report on excavation methods which is already in the hands of the Commissioners, and a more extended analysis of these same contracts and prices is contained in Mr. [illegible]' answers to the contractors' evidence.
(See also transcription of Mr. [illegible]' recent evidence before the Commission).

Question 2: By what percentage was it anticipated that the use of extra large shovels and electrically driven equipment would reduce the cost of rock and earth excavation?

Answer: These figures are set forth in detail in Appendix No. 7 of Mr. Acres' report of December 26th, 1917. (See also the statement of Contractor Heyworth in Mr. Goodwin's report on excavation methods on the Calumet-Sag Canal).

Question 3: In submitting a report to the Chairman of your Commission under date of January 11th, 1917, comparing the plant proposed by your Commission with that proposed by Messrs. Baldry, Yerburg & Hutchinson, Mr. Gaby stated that to do the work in a three-year period you contemplated the following equipment:

Drag Lines and Shovels	5
Steam Locomotives	6
Electric Locomotives	10
Dump Cars	200

Was this actually the amount of equipment that you had figured on. Taking into consideration the actual output of each unit of plant installed do you consider the work as originally contemplated could have been done within the three year period with this amount of equipment?

Answer: The above specified items did constitute the actual estimated amount of equipment figured on, more particularly in respect of the shovels and dump cars.

This matter is covered fully in Mr. Acres' answers to the contractors' evidence.

The answer to the second part of this question is "Yes". It

must be remembered, of course, that the capacity of the canal at that time was 6500 cubic feet per second.

<u>Question 4</u>: On the same basis so referred to in the above questions Mr. Gaby stated that the total number of men required to operate the plant as referred to above was 191 men, as compared with 660 men proposed under the Hutchinson organization. On the same basis, as above, do you think the work was possible of accomplishment within the three-year period with this number of men to operate the equipment?

<u>Answer</u>: Yes.

<u>Question 5</u>: Explain in a general way what steps were taken to provide the plant necessary to carry on the work, and how soon were orders placed after authorization was received to proceed.

<u>Answer</u>: This particular phase of the situation has been explained as fully as it would seem possible to explain it in Mr. Francis' reports, more particularly his Chronological Charts, page H-98, referring to excavating units, and pages H-93 to H-98, inclusive.

The first large order for plant was placed the day that the purchase of same was authorized by the Commission. This matter is further referred to in Mr. Acres' report on the contractors' evidence.

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Question 6: How soon after you had commenced preliminary operations did you realize that the original amount of equipment estimated upon would be insufficient to do the work?

Answer: When plans were changed to enlarge the capacity of the canal previous to the Spring of 1918.

Question 7: Were complete plans made before actual operation commenced for service railways, disposal area trestles, and other services and were these services entirely completed at commencement of operations or were they added to from time to time as the work progressed?

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Answer: Insofar as the original 6500 second foot canal was concerned, complete plans for service railways and other auxiliary services were made before operation commenced, and these plans were enlarged from time to time as conditions changed. There were no plans for the disposal area trestles, because no plans were needed. Procedure in this regard was limited to the issue from the field office of sketches of standard trestle for the use of the trestle foreman. These services were necessarily added to from time to time as the work progressed, because the scope of the work changed from time to time. This has been fully explained since the beginning of the inquiry.

Question 8: Explain in a general way the reasons governing your decision to commence operations at Bowman's Gulley and the method in which the work was proceeded with from this point. In answering this question it is not necessary to give details of yardage and so forth, as these are all contained in Mr. Francis' report. What is required is a general explanation of the reasons leading to the placing of plant and so forth.

Answer: This matter was referred to Mr. Acres' recent evidence before the Commission, and is referred to again at considerable length in his answers to the contractors' evidence.

Question 9: In January 1917, as already pointed out, Mr. Gaby stated that only five shovels and drag lines would be required on the work. It is understood that by December of 1917 you had 5 electric shovels and 2 steam shovels on the work, that by June 14, 1919, you had 2 more electric and 1 steam shovel added, and that during 1920, 3 steam shovels and 1 steam ditcher additional were in operation. From this it will be noted that even after your report known as Estimate No. 2 bearing date January 10th, 1918, in which you state that sufficient equipment was then on the work to complete operations for a 10,000 second foot canal by October, 1921, with equipment mentioned in your report as being then already purchased, the record shows that in July of that same year electric shovels Nos. 8 and 9 were purchased. Following this, shovels were again purchased in May and October, 1919,

and July, August and November 1920. Why was the purchase of equipment spread over such a long period and why was it necessary to increase it so soon after the statement contained in your report above referred to?

Answer: The reason why it was necessary to increase the original amount of plant so soon after December, 1917, was the decision to increase the canal to 10,000 cubic feet per second capacity. When the statement was made in connection with Estimate No. 2 that sufficient equipment for the construction of a 10,000 second foot canal was already purchased, it was doubtless due to the fact that in 1917 a recommendation was made for the purchase of two more electric shovels in order to make good the original schedule with the added quantities involved in the 10,000 second foot enlargement. This recommendation was probably in mind when the statement was made that sufficient plant was available for the purpose intended. In fact, it was decided that this plant be not purchased at the time, in view of the disturbed state of the market, and it was not until the following Spring that the order was placed.

Question 10: When estimate in the amount of approximately $25,000,000. dated January 22, 1919, was made, giving a canal capacity of 15,000 cubic feet per second, an installed capacity of 300,000 h.p. and an ultimate capacity of 500,000 h.p. did this estimate take care of all the necessary increases in the size of the canal, the lining of the canal

and other works, excepting the final intake design for the works as at present constructed?

Answer: No such estimate as the one above specified was ever made by the engineers of the Commission. This particular matter was explained at great length in Mr. Gaby's and Mr. Acres' evidence before Mr. Rowell, and has also been further amplified and explained in Mr. Acres' answer to the contractors' evidence.

Question 11: In making the estimate above referred to, it is understood that same was based upon Estimate No. 2 which in turn was based on the unit prices used in the original estimate submitted to the Commission by Mr. Gaby in January 1917. Had not unit costs of work increased materially above the cost as estimated in 1917, and if so why were the actual costs not used in preparing this estimate?

Answer: The same answer applies in this case as to Question 10 above. The reason for not increasing the unit price is fully explained in the documents above mentioned, and in the curves and exhibits which accompany them.

Question 12: Describe in a general way the main items of expense involved in the cost of unwatering, which it is understood amounted to approximately $1,000,000.

Answer: The conditions and reasons which led to the expenditure of the

above specified amount of money in unwatering, are fully detailed in Mr. Acres' answers to contractors' evidence. As to the "main items of expense involved", it is not definitely understood whether these items are required under the headings of capital cost, operation, maintenance, etc., or under the headings of pumps, flumes, ditches, sumps, etc. The information under these headings is all contained in the records, and can be made available on further request, if necessary.

Question 13: When the work was commenced, were operations put in hand having definitely in mind a three-year period of construction. With the changed conditions necessary under the provisions of Estimate No. 2 for 10,000 second foot canal, were plans and operations so made that the work could be completed as then contemplated with the equipment therein stated to be necessary as at October, 1921? If so, with the actual output of the various items of plant, and comparing same with the output as estimated upon, do you now think that it would be possible to accomplish the work within the various periods had conditions remained the same as when the various estimates were submitted by you to the Commission?

Answer: The answer to both portions of this question is "Yes".

Toronto, July 23rd, 1923.

above specified amount of money in construction, are fully detailed in Mr. [illegible] summary of contractors' evidence. As to the "main items of expense involved", it is not definitely understood whether these items are required under the headings of capital cost, operation, maintenance, etc., or under the headings of pumps, flumes, ditches, ranges, etc. The information under these headings is all presented in the reports, and can be made available on further request, if necessary.

Question 12: When the work was commenced, were operations put in hand having definitely in [illegible]-year period of construction. With the changed conditions necessary under the provisions of Schedule No. 2 for 12,000 second feet canal, were plans and operations so made that the work could be completed as then contemplated with the equipment [illegible] to be necessary as an [illegible]. If so, with the actual output of the various items of plant, and comparing same with the output as estimated upon, do you not think that it would be possible to accomplish the work within the various periods had conditions remained the same as when the various estimates were submitted by you to the Commission?

ANSWER: The answer to both portions of this question is "Yes".

Toronto, July [illegible], 19[illegible].